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[OFFICIAL NOTICE.]

OFFICE AMERICAN GAS LIGHT ASSOCIATION,
142 CHAMBERS STREET, NEW YORK.

To the Members of the Association:

The VIII. Annual Meeting of the Association will be held in the city of Chicago, on the 13th, 14th and 15th days of October next.

That this meeting may be lacking in none of the valuable features that have characterized the gatherings of the past, the Secretary, thus early, calls your attention to the importance of individual effort to make the coming meeting worthy of the Association, by the preparation of papers, or by the possession of some valuable information to be otherwise contributed to the general sum of instruction on that occasion.

This is the season of renewal and extension of plant, and the observant manager cannot fail to find texts and data in the results of the past season and in the condition of his various apparatus (handwritings, as it were, on the wall) that, rightly interpreted, open the path to economic and successful management.

Notes of such observations, data of experiments tried and results had in everyday workings form the valuable basis, either of fact or theory, upon which the most instructive papers may be written and interesting debates founded.

It is largely to such observations that we are indebted for the material and scientific advancement in gas manufacture that has marked the last decade, and the various kindred Associations have been the invaluable vehicles that disseminated the knowledge thus obtained; hence we owe it to ourselves and our fellows that our share of the good work be equally well done in the future.

There is no lack of subjects entirely germane to the purpose, it is rather a confusion of riches that besets us; the whole wide realm of gas manufacture and distribution; our commercial, scientific and social relations; personal views of management and experiences is open to the choice and is within the reach of all; be our attainments purely practical or thoroughly scientific there is yet matter suited to every mind.

You are, therefore, requested to assist, each in his own way, to the end that papers of interest may be presented at the meeting, and its deliberations be made of value to all.

WM. HENRY WHITE,
Secretary.

GAS FURNACES.

In our last issue we gave two very valuable papers that were read before the British Association of Gas Managers, at their recent meeting in London, by Mr. Frank Livesey and Mr. G. E. Stevenson, and to-day we give the discussion thereon in full.

We would urge upon gas managers a very careful study of the papers and the discussion, inasmuch as this is the beginning of an experimental investigation of a subject which is to wield a very important influence in the future of coal gas manufacture. This matter was brought out and urged upon the attention of our people by the discussion in the New England Association last winter, and we are very glad to say that in several works steps have been taken to make practical tests of some furnaces designed in this country (Dieterich's), while in one of the large works in New York city the Liegel system is being tried, so that by the next winter's meeting it is to be hoped that something further may be added to the record of practical results obtained in American works by the improved method of heating benches.

The British Association were peculiarly fortunate in having present with them Dr. Siemens, the founder and father of the Regnerative System, to open the discussion; and his remarks upon the "Reciprocative Regenerators" will be found especially interesting and instructive. It is probably to him more than to any other one man that we are indebted for the development already attained of the system of heating by gaseous fuel; and if the gas interest had been as much alive to their real necessities as those managing the iron interest, there is no doubt but a much larger portion of Dr. Siemens' great ability would have been availed of by the gas makers of the world, and they would have found themselves to-day far in advance of the point they occupy in the matter of the scientific application of heat.

It would seem strange that, in a manufacture where so much depends upon the proper application and regulation of heat, such a statement could be made truthfully; but, nevertheless, we believe that it is true, and that

the time is not far distant when men who now employ the system so long in use, and so unscientific in its working, will wonder at their own want of progress in this matter.

Mr. West, of Maidstone, in his remarks, brought out one point that, so far as American works are concerned, covers a very important feature of the business, viz.:

"He was firmly convinced that there was a saving of fuel, but he did not attach so much importance to this as he did to fact of a regular heat, because in this way they could obtain a larger volume of gas"

On the Continent of Europe fuel is a very important item, and brings a very good price; but with us this is an item of less importance from the greater abundance of cheap fuel. The money value of the gas obtained is much greater in proportion to the value of coke than it is in Europe owing to the double cause of low priced coal and higher priced gas.

The point for our managers to reach is to get the most possible out of a pound of coal, having due regard of course to the illuminating power. The man who can increase his sales one foot per pound is getting an increase of 2,240 feet of gas to the ton, which, in other words would very nearly pay for his ton of coal; so that it becomes a question of vital importance to apply that system of heating benches which will give him the greatest increase of yield, and if an economy of fuel accompanies the application of the system, so much the better.

It is a question that must be studied broadly, and with all the ultimate results taken into the account, and, when properly considered, it would seem very evident that the outlay necessary for a proper system of heating is one of the best investments any company can make.

This brings us to a point often urged to the effect that small works cannot afford the expenditure. This we have always believed to be an error, and we are exceedingly glad that we are able to submit the testimony of two such competent witnesses as Mr. Frank Livesey and Mr. Stevenson on this point, who both stated, in substance, that the extra cost would be repaid in a short time; and, in fact, that a majority of the works in Germany using the furnaces were very small works.

The system is no longer experimental on the Continent of Europe, and we hope the day is not far distant when the same may be said of the United States.

Gas Explosion in Detroit.

About fifteen minutes before 12 o'clock last Monday night, as a gentleman and lady were passing the Shaary Zedeck Synagogue on the southeast corner of Congress and Antoine streets, Detroit, a tremendous explosion suddenly deafened their ears. From every window of the edifice shot forth a mass of fire, the fierce and sudden blast tearing the sash and throwing the woodwork and stained glass into the street with fearful force.

The awful explosion, although issuing only from the windows and doors of the edifice, blew them both off the sidewalk. They did not lose their feet, but the girl was swept to the other side of the street like a reed before the blast of a hurricane. Her male companion, of stouter build, was not blown so far. Recovering from the shock he hastened after her to be assured of her safety. The explosion threw Eliza Davie to the ground on the crosswalk, and the blast rolled her over and over till she nearly reached the corner diagonally across from the building. The next sound was the tearing and crashing of timber, and the noise of falling glass, which sounded like the wreck of 100 crates of crockery thrown from a height to the ground and then came darkness and silence again. The surrounding houses, their inhabitants roused from sleep by the appalling din and the frightsome light, awoke to life again. Lights gleamed in the windows, and the occupants came forth to view the scene of ruin.

The firemen in engine house No. 2, on the corner of Antoine and Larned streets, were awakened from their slumbers by the noise of the explosion. The gust of air which followed it extinguished every gas light in the building. They rushed down stairs some thinking that the fire tower had fallen, and others that the boiler of the fire engine had exploded.

All this took place in one-hundredth part of the time required to tell it. In a few seconds the fire alarm was sounded, and No. 3 was at the spot in about a minute. Fire was then issuing from a basement window on the Antoine street side of the synagogue, about 20 feet from the corner. The flame was mostly of a deep blue color, intermingled with fire of the usual character of burning wood. In a few seconds the flames were extinguished, and Chief Battle stepped into a front room in the basement and found that the fire had resulted from the escape of gas. The connecting pipe of the main, to which the gas meter is attached, is 1¼ inches in diameter, and this was found to be open, the screw cap having been removed. A wooden plug was made and driven into the pipe, and the engines then withdrew for want of employment.

The explosion created great excitement throughout the city, but strange to say, nobody was hurt. A large number of the windows facing the side of the synagogue were broken, and the sash and plate glass lights of the drawing room were blown in and smashed to pieces. A piece of the lead frame of the stained glass windows of the synagogue, rolled up, bent and twisted, was found on the carpet.

The interior of the synagogue presented a scene of wreck and ruin which can hardly be described. The gas escaped from the service pipe in a small room in the basement about 12 feet square. Here it was connected with the meter, but the latter was taken away about a year ago, after the church was closed by foreclosure of mortgage, and the end of the pipe was covered by a cap screwed on. This was a corner room, and two of the walls were the walls of the edifice itself. The other two walls were of lath, plaster and joists, and these were blown away outward like card boards. The walls of another room adjoining were also leveled with the floor. In the Sabbath-school room, in the rear, the concussion had only one thing to attack—the hot air furnace—and that was completely wrecked, the iron pipes and connections being torn and twisted like sheets of paper. Every window in the basement on both sides was protected by a woven wire guard, and sash, glass and guards were all blown outwards. In the floor above—the auditorium of the synagogue—the damage done was very great. That above the meter room was denuded of flooring and seats for a space of twenty square feet, and the gallery on the west side was torn and damaged for half its length. Pieces of the flooring were thrown up into the ceiling, twenty-five feet above, and the latter showed great gaps from which the lath and plaster had been shaken by the explosion.

A large crack running around the cornice showed that the force of the explosion had partially lifted the entire roof of the building. The glass windows on the sides, the large one in front, and seven circular windows in the rear, over the sanctuary, were all blown out into the street, and enclosure on the west side, making a scene of ruin sad to behold.

The loss is estimated at about $4,000.—*Exchange.*

Exhibition of Apparatus for the Utilization of Gas and Electricity.

[We publish below a letter which speaks for itself, and we ask for it a hearty response from this side of the water. If our people will not get up an exhibition of their own, it is most sincerely hoped that they will do something towards contributing to those abroad. Should any of our readers desire fuller information as to the details, we shall take pleasure in sending them the prospectus, which contains full information. The names of the managers are a sufficient guarantee for the success of the exhibition; and another fact that will add much to its value is that the West of Scotland Association meets during the time of the exhibition. We wish them every success.]

SECRETARY'S OFFICE, 154 VINCENT STREET,
GLASGOW, July 23, 1880.

To MAJOR G. WARREN DRESSER—

Sir: I am directed by my Committee to forward you copies of the Prospectus of the above Exhibition (each having enclosed a form of application for space), in the hope that you will be so kind as to take the trouble of having them addressed to parties likely to become exhibitors. There is plenty of time, and applications from abroad will be favored in that respect. We look forward to having a good representation of the genius of the American people at our Exhibition, which is the most important of the kind yet held in Great Britain, and the first which has embraced *electric* lighting as well as gas.

Anything in the "conditions" of Exhibition that may seem to your friends to be restrictive, will be modified, you may assure them, in the most liberal spirit, to facilitate their coming forward as exhibitors.

Thanking you, by anticipation, for the trouble I am giving you, I remain

Your most obedient servant,

JOHN MANN,
Secretary.

HIGH RAILROAD SPEED.—In a recent discussion or the question of high railroad speeds, at the Franklin Institute, Prof. Marks stated that he had made some calculations as to the maximum speed at which locomotive engines could be driven before the centrifugal force on the tires of driving-wheels would become so great as to cause them to burst. These calculations which were approximate only, gave a limit of speed in the neighborhood of 150 miles per hour; of this, 78 miles, or more than half, has already been attained—*Sci. Press.*

IT would seem as though the illuminating gas of New York was rich enough—certainly it is as rich as people can burn without smoking, yet in Harry Miner's Theatre they propose passing the gas through a gasoline machine. Carelessness in handling the gasoline the other night resulted in a fire, deservedly destroying the machine, but doing little other damage.—*Sanitary Engineer.*

Seventeenth Annual Meeting of the British Association of Gas Managers.

Below is the discussion which followed the reading of the two papers upon "Retort Furnaces" and "Regenerative Furnaces," by Mr. Frank Livesey and Mr. G. E. Stevenson respectively, which were reproduced in the last issue of the JOURNAL:

Discussion.

The President said the subject of regenerator furnaces was novel to the Association, but he did not think on this account that the discussion would be by any means less instructive. He was glad to see among them the illustrious inventor of the regenerator furnace, and they would be under very great obligation to Dr. Siemens if he would favor them with his views on the subject.

Dr. Siemens said the authors of the two papers before them had drawn a distinction between the furnaces they had described and the Siemens regenerator furnace, but if too much time had not passed since his early experiments it could easily be shown that the furnaces now put forward had a very strong family likeness to the very earliest furnaces he adopted. In the first instance he very naturally confined the regeneration to the air, using a gas producer very much of the form shown in the diagram, in order to supply the furnace with heated gas. In one variety of that furnace in which the currents were not reversed, he used tubular regenerators; but he soon convinced himself that in doing away with the reversing action only a seeming simplification was effected, for it was far easier to maintain in good working condition brickwork loosely piled into a chamber, than flues through the sides of which heat had to be transmitted. In the one case there was no leakage, and in the other there was, as well as breakages of the flues or tubes employed. He therefore soon abandoned the tubular regenerator, and confined his attention to the reciprocative regenerator, in which the currents of cold air and of hot products of combustion were reversed from time to time. The gas producer was at first closely attached to the furnace in a similar manner to that shown, but he found that two evils arose from this construction. In the first place, the temperature attainable in such a furnace was much below that which resulted if both air and gas were regenerated. This objection would not, however, apply to gas retorts where the heat to be attained was only moderate. But another evil was this, that when reversals of the current were employed the quantity of the products of combustion which was available for heating the regenerator must be larger than the quantity of air that came in to take up this heat again. Hence it followed that the air regenerator became gradually heated right through to the chimney end. In order to attain perfect regulation, the volume of gases which ascended through the regenerators, in order to take up heat, must be equal to the amount of gases passing through the furnace in order to give up that heat. The Paris Gas Works had been specially mentioned in the first paper, and he was somewhat struck with the omission of his name in connection with them, because it was now nearly twenty years since he first designed furnaces for the Paris Gas Company, and the Vaugirard works were by degrees entirely changed in favor of his system. His arrangement with the Company was to the effect that they should ascertain their saving in fuel, and pay him a percentage of the saving as a royalty. For a number of years the Company returned a saving of 35 per cent., which, as it was their own determination, he might take for granted was not against themselves. These furnaces were supplied from separate gas producers, in which water was admitted under the grates; and they had the air and gas regenerator. The success of this furnace was complete, and other retort benches were put up on the same system one after the other. He admitted that the system was a costly one, and he could see in the recent endeavors to modify the arrangement a natural desire to economize in the first cost. At the same time he noticed a reduction in the percentage of saving from 35 per cent. to 25 per cent., and this was just such a result as he should have expected, because, in order to get the maximum economy, it was essential to have a separate gas producer and the double regenerator. The author of the first paper mentioned the fact of water being introduced at the bottom of the gas producer as a means of improving the draught; but he (Dr. Siemens) must confess that he never looked upon it in that light, and did not see well how it could improve the draught, nor did they want much draught in the producer. The effect was entirely a chemical one. If water or steam was introduced at the bottom of the gas producer, especially when coke was used as the fuel, the decomposition of the water or vapor took place in passing through the lower part of the fuel in the gas producer where the temperature exceeded the point at which water was decomposed in contact with heated carbon. Carbonic oxide and hydrogen gases were thereupon developed, which in their formation absorbed or rendered latent a very large amount of heat, and this heat was reproduced in the furnace when the gas raised from the decomposition of the carbonic oxide and hydrogen met with heated oxygen in combustion. Therefore the introduction of vapor or water at the foot of the gas producer resulted in simply a transportation of heat from the point in the producer where it was not wanted to the furnace, where it was wanted. There was no creating heat in it, nor could direct advantage be claimed beyond that of carrying the heat from one point to another. There was, however, an incidental advantage in the admission of water or steam, in that it kept down the temperature of the fire grate and prevented the brickwork being injuriously acted upon. He had for the first time seen the modification of the regenerative furnace to which Herr Liegel's name was attached. Many years ago he tried to construct gas producers with an accumulation of heat at the bottom to render the slag fluid, in order that it might run off instead of being dragged out of the bars, and if this could be practically accomplished a very great gain would no doubt be effected, because the clinkering of the bars not only involved a considerable expenditure of labor, but much loss of fuel, which must necessarily be dragged out with the clinker. The great difficulty which he experienced, however, was that the clinker would not melt under all circumstances. Sometimes it would, if it happened to be of a fusible composition; but in dealing with other descriptions of fuel the clinker would not melt, and instead of flowing at the bottom it only clogged up the producer. He should be much interested to hear of the success of the proposed furnace in this respect. In conclusion, he could only thank the President for the opportunity he had given him of expressing his views on this subject, and the pleasure he felt in seeing that the regenerative system was at last finding favor with gas engineers.

Mr. J. West (Maidstone) said the first time the importance of this subject was impressed upon his mind was when the members of the Association visited the Paris Gas Works. He then came to the conclusion that the system of heating retorts there adopted was in principle the proper one; but he was not aware until now that Dr. Siemens was the prime mover and arranger of the system. He was, however, glad to inform him that he had certainly set his (Mr. West's) mind upon it; and seeing that he had not himself time to go into the matter, he tried to find some one in England who had some experience of the principle, not being aware at the time that Dr. Siemens had arranged the retort furnaces in Paris. Knowing that they should at some future time erect a new retort house at Maidstone, he was very anxious to obtain the assistance of someone who had a knowledge of the working of the principle, and he came across Mr. Stevenson, who was acting on behalf of Herr Liegel. He talked the matter over with him, and the result was that his company arranged for a few of their new retort settings to be erected upon that plan. They had intended to make a complete experiment, and to lay the results before this meeting, but they found it impossible to get anything done in time. He further stated that after he had made a start and arranged with Mr. Stevenson, he found that Mr. Livesey was working in the same direction. He had also another plan which he intended to work side by side with Liegel's system, one which was a combination of two or three of these furnaces which Mr. Livesey and others had arranged, for the object of gas managers should be to get at the best possible plan. He did not care whether it was Siemens's, Liegel's, Livesey's, Somerville's, or whose it was; what they wanted, first of all, was to satisfy themselves that the principle was a correct one, and of this he thought there could be no doubt. He was firmly convinced there was a saving of fuel, but he did not attach so much importance to this as he did to the fact of regular heat being applied to the retorts, because in this way they could obtain a larger volume of gas than they could at present. They were all aware of the great loss of volume and illuminating power under the old system, where they had to empty the furnaces, during which time the cold air was rushing through them. Then they had to be heated again from the sides of the furnace, and the heat had to be transmitted from the hot furnaces to the cold coke. Now in any regenerative system the coke was left in a mass for months. In the case that had been mentioned in the first paper the furnace was not emptied for three months, during the whole of which time there was a constant and regular heat—that was to say, if the bottom slit of the furnace was attended to in a proper manner. As to the objection which Dr. Siemens had urged, that it might not be possible to run the slag off from the bottom of Liegel's furnace, he could only say that he had a difficulty in preventing the running down of the bricks; there was no doubt about the slag. The difficulty was to get a material to stand the intense heat of the bottom of the furnace. They had only put the furnace to work about a fortnight previously, and they had been in actual working about eight days, during which time, although they had not had any figures prepared, he had seen enough to convince him that it would be the system of the future. The men took well to the system, and although it had only been started a few days they were already up to the regular make of 8000 feet per mouthpiece; and he anticipated in a short time they would go on increasing, because they all knew that retorts only lighted a few days could not be expected to produce so much gas as those which had been alight six months. He was very desirous that the whole system should be thoroughly

gone into. It was important that it should not be left in the hands of any single individual, and he would suggest that the Association should inaugurate and adopt some system whereby a few scientific men might be brought together who would fully investigate a system of this kind, or any system which was worthy of consideration. He himself had not the time to go into the experiments in the way they should be gone into, and therefore he thought there should be some gentlemen appointed who should go down to Maidstone, where they would have liberty to do as they liked, and test this system when it was ready. What they wanted to know was that they had the best furnace, which could produce the best results with the least expenditure of capital. His own impression when he was in Paris was that the system was a good one, but that the paraphernalia in connection with it was too elaborate, and that it might perhaps be worked out in a more simple way. What they wanted to know was whether it would be worth while to spend the extra money in producing probably better results. This would be a matter of calculation, but he was firmly convinced that good results would arise from the system.

Mr. W. J. Warner (South Shields) thought this matter had really been carried beyond the experimental stage. It was no new system, for he remembered having seen it in the Birmingham works many years ago, although it was not so successful as to warrant its continuance. But that was only with reference to gas works; its application to glass works was almost universal, and on the Continent it was being worked constantly. Only a few days previously he passed through some enormous plate-glass works on the Tyne, where this system was going to be thoroughly adopted, and he might tell them what was said by Mr. Charles Mark Palmer, on visiting his works. He said, "What! you use coke furnaces! You are twenty years behind the times." He (Mr. Warner) thought there could be very few experiments required to confirm the economy of the regenerator furnaces, as had been proved on the Continent, where so much attention was paid to the subject of fuel for furnaces.

Mr. G. Livesey (London) said he regretted he had not lately been able to give so much attention to this interesting work as he should have liked, from being occupied in other ways. The Siemens furnace was universally known, and it was thus hardly necessary to make special mention of Dr. Siemens's name, as every one knew it. The different applications of the principle were for them to carry out. There had not much been done in England certainly with regard to the heating of gas retorts on the Siemens plan, but what he saw at one of the Paris works some years ago convinced him that it was the right system, and ever since he had been thinking of it. A year or two ago, at the South Metropolitan Gas Works, they began to make experiments, but difficulties arose because the circumstances varied, and it was therefore not practicable to copy exactly any given system; it had to be adopted to suit special circumstances. Some twelve or fifteen years ago Mr. Frank Clarke Hills, whose name was well known in connection with gas works, gave considerable attention to the utilization of waste heat, and patented a plan to make use of it to heat the air that fed the ordinary furnace. He placed in the flue, under the bottom retort, a cast iron pipe 9 inches by 4½ inches, which went the whole length of the setting. Air that entered at the north end he made to travel to the south end, to feed the south furnace, and for the other side the air entered the south end, traveled to the north end, and fed the north furnace. The result of heating the air was remarkable, and showed there was much to be gained by it; but they were obliged to give up this plan of Mr. Hills's, because it was too good—it melted everything; it melted the bars completely. Then an attempt was made, both at their works and at the Chartered Company's works, to do without bars, and to have brickwork only; but that melted in the same way—everything was carried away by the immense heat. This showed the enormous loss that was being sustained by the heat that escaped after it had done its work in the ordinary settings. Now, applying this to the Siemens principle, he thought they had a process which would result in a great benefit. Dr. Siemens spoke about the percentage of saving, but he (Mr. Livesey) would remind him that the application of his furnace in England was in its infancy; it was not yet complete and perfect. For instance, with regard to the settings, to which his brother had referred, there was one great defect, that the hot air flues were of brick underneath the flue of the bottom retort, and it was impossible to keep brickwork tight. He was quite satisfied that the cold air was being drawn into the retort flues, and only a portion of it was heated and reached the combustion chamber above the furnace. A considerable proportion he was satisfied was sucked through into the ordinary flue, and carried away up the shaft, thus having a detrimental effect in two ways. The idea which led them to adopt the second plan was this: They noticed that in the stage house, where the regenerative furnace was placed, there was an enormous heat radiated from the furnace itself, and the idea at once occurred: "Here is a great loss of heat through the brickwork; cannot we adopt the Siemens system in the setting itself?" He had no doubut the plan would be somewhat modified, but so far it it seemed to have a beneficial effect. As his brother had explained, they had a deep furnace, and supplied the hot air above the fuel, which was not dealt with so well as it would be when they had iron tubes for heating it, and they also prevented clinkering by means of the steam at the bottom, which was a great point to have accomplished. One had only to go into the archway and look up into the furnace to see that there was no intense heat there. The steam by its decomposition simply transferred the heat from where it was not wanted to where it was wanted, and there was no trouble whatever with the clinkering. This principle carried out further would, he believed, be found very beneficial. He quite agreed with what Dr. Siemens said about carrying out the principle in its entirety—namely, reversing the current; but there was great difficulty in applying this to retort settings—there was not room for the chambers for heating the air. They were at present content with endeavoring to get the proper amount of heated air, and he thought they would be able to obtain a sufficient amount of hot air from the waste heat in the flues. He intended in future to have the main flue under the setting, instead of on the top of it, by passing the air tube through this flue where the heat had done its work as far as the retort setting was concerned. By this means they should get the air heated to a sufficient extent to accomplish all they required without the reversing chamber. He was satisfied that in England they were behind the Continent in this matter, probably because fuel was so cheap they had been wasteful and extravagant with it. He did not feel that the gas men of England would be doing their duty unless they pursued this object further, and he had no doubt that they would be rewarded with success.

Mr. C. R. Mead (Sutton) said that the general public gave gas men the credit of being very much behind the times. Mr. Warner told them they were twenty years behind; but he (Mr. Mead) was afraid they were twenty-five years behind, for it was just twenty-five years since he had had the pleasure of testing one of Dr. Siemens's regenerating furnaces. The furnace he had put up did not require more room in the retort house than the present bench of retorts, except it required more depth. In that case the furnace gases were turned through two flues under the ordinary settings. The flues were built with hollow walls—that was, simply bricks laid loosely in—with aperatures between the bricks, so that the furnace gas, after having passed to the retort ovens, passed through these hollow walls to get to the chimney. When the bricks on one flue became thoroughly heated, a valve at the back of the flue was shifted, and this turned the air that went to supply the furnaces through the flue containing the hot bricks. There was no question in the world that the saving in heat was enormous, and the only reason why it did not succeed in the small works where he had tried it was that the men who had charge of the work, and ought to have reversed the valves, neglected to do so. He wished to impress on those who spoke of its not being practicable in England, on account of the room it occupied, that it really occupied no more room in the retort house than ordinary settings. The whole of the regenerative furnace and flues might be placed on the ordinary settings, and required no more length than was used now. That the system would become universal he had no doubt, though he had very great doubt that his friend Dr. Siemens would get the benefit of it.

Mr. S. Hunter (Salford) said he thought it very desirable that a system of this kind should be tested, but as for adopting it in works having an underground arrangement simply consisting of an opening in the floor, and expecting men to go into the chamber, where an intense heat must prevail, it would probably result in failure. Perhaps they might have some information as to what class of works should turn their attention to the adoption of this method. He saw no difficulty about it in large works where they could apply a stage floor, where there was plenty of height and a space beneath the floor; but he thought there would be great difficulty in small works.

Mr. A. F. Wilson (London) said that his experience with reference to the adoption of this apparatus in small works was this: Some few years ago his attention was directed to the subject, and he had thought of it a great deal since. Three years ago a furnace was put up in some works he was in charge of, and it was very successful. The setting in these works was the ordinary setting; there was nothing underground, but they took out the middle retort and formed a deep furnace, the form of which was very much like diagram Fig. 2. This was so successful that they at once adopted it to eight or ten furnaces, and after three years' experience the results were so satisfactory that he should have no hesitation in recommending its adoption in even the smallest works. It was a mere question of designing the retort bench, if a new one were being built; but where the benches were already built they could be converted by withdrawing the middle retort. On the question of wear and tear, he thought six retorts in an oven more economical than seven. They made a chamber for the combustion of the gases in the centre of the furnance, and built a deep furnace with two doors. This was practically a regenerative furnace. The works he referred to were those at Aldershot.

Mr. Denny Lane (Cork) said he was very glad that the honor of this improved furnace had been restored to the original inventor, Dr. Siemens, for he feared, when he heard the name of Liegel and others connected with an invention which was solely and indisputably that of Dr. Siemens, that he would be denied the credit of it. To put the matter in a practical point of view: What gas managers were suffering from at present was the too great ability of Dr. Siemens; because if he were not a man of such great powers that he had managed to apply scientific principles to so many practical objects—if his attention had not been diverted by his great improvements in the manufacture of steel, by the great electrical achievements by which he had spanned the oceans with electric wires, and by so many other subjects—and had paid a little more attention to the special application of the regenerative system to gas works, the whole question would have been solved long and long ago. They were suffering from an *embarras de richesse* of Dr. Siemens's mind; but if at any time his learned friend could contrive to limit his genius, and, like Burke, give up to gas works what was intended for mankind, the whole question, as far as gas managers were concerned, would be exhausted.

Mr. W. Carr (Halifax) said they were very much indebted to the authors of the papers for coming forward with their very limited experience of the furnaces they had been trying. When he was in Paris two years ago he, like Mr. West, was struck with the effect of the regenerative furnaces there, and felt satisfied that it was a step in the right direction, and one which ought to have been taken long ago. The difficulty he had always had to contend with, for he had aimed at getting the highest heats possible, had always been the destructiveness of the furnaces in which great heat was obtained. As the furnace had to be placed in close proximity to the retorts themselves, when the furnace went the retort setting went with it, and great damage was done, and great wear and tear was occasioned, which meant a loss of money and not an economical system of working. He had tried in various ways to obviate this difficulty, but the only real and certain system of getting rid of the objectionable feature was not to work at such high heats, which, to his mind, meant a loss of profit at the end of the year. But the way out of the difficulty seemed to him perfectly clear when he saw the furnaces in Paris. From the discussion that had taken place, he thought there was no doubt about who was the author and inventor of the principle, but Dr. Siemens would allow that other people had tried to modify his arrangement, and to make it applicable to the circumstances of those people to whom the arrangement which obtained in Paris was not quite so convenient as it might be. Dr. Siemens said that he himself had tried various systems from time to time, and all that was claimed by the authors of the papers for the different names that were mentioned was that the arrangements described were not inventions, but applications of the Siemens principle. He was somewhat in doubt as to the exact point where Mr. Mead left them when he closed his remarks. He said he had tried this system twenty-five years ago, and found only one fault in connection with it—that the men would not change the valves at the right time. He (Mr. Carr) did not know whether Mr. Mead had come to the conclusion that the progress of evolution had gone on at such a rapid rate that men were now fit to be entrusted with the duty, it was a great pity that some effort was not made at the time to obtain the help of some men who would have attended better to the regulation of the valves. For their sakes it was a pitty, as Mr. Denny Lane had suggested, that Dr, Siemens had not devoted more attention to the subject of gas furnaces; but, as far as the community at large was concerned, there was no doubt the work he had done in the scientific world had been of gigantic benefit, and they were much honored by having him among them that day, and hearing the very clear and lucid speech he had made, and the forcible manner in which he had put some of the fundamental principles of the regenerative furnace before them. Personally he felt very grateful to him, and he had no doubt, from the reception his name had met with, that the feeling was expressed by every member present. With regard to the question of regenerative furnaces, he should endeavor to do something to further the object they all had in view, and he hoped that it would not be long before they had such a system of regenerative furnaces at work that they might be able to attain something like a uniform temperature in carbonizing, and when that came they would have advanced a considerable stage toward a more profitable and scientific application of their business.

Mr. G. Anderson (London) said this was one of the things he had something to do with. He had heard a good deal about these regenerative furnaces, but sometimes their friends were in a considerable difficulty from not having good accommodation. In some places it was not possible to go down a couple of feet below the floor without getting into water, which was a bad way of getting steam. However, he could deduce from what he had heard that there was great advantage from these furnaces if properly applied. One thing which struck him in reading about them, which he had not heard answered by the readers of the papers, or even by Dr. Siemens, was that all these regenerative furnaces were argued from the principle that a saving was effected because the carbonic oxide was converted into carbonic acid. But supposing all the fuel was converted into carbonic acid, without the secondary process would there be a saving of fuel? This was a question he should very much like Dr. Siemens to answer. The reader of the first paper said there must be 3 or 4 feet in depth of fuel; or carbonic oxide could not be made. Granting all this, if he had only 18 inches of fuel with which he could heat retorts very well, and which produced carbonic acid, where was the advantage of first producing carbonic oxide, and then giving it another atom of oxygen to make carbonic acid? No doubt the doing away with clinkering of the fires would be a grand thing, for the opening of the furnace for a quarter of an hour or twenty minutes to take off the clinkers, while large volumes of cold air were rushing through the furnace and cracking the retorts, was a thing which would be avoided with these furnaces. Another question he should like to ask was this: It appeared to him that an inferior fuel might be used with these furnaces; but could breeze be used, or breeze and coke, instead of all coke, as at present? If the full calorific value could be obtained out of the breeze it would be a considerable advantage, because it did not fetch the price it ought to, considering its calorific value. These were questions which those who were trying the furnaces would be able to answer when they had tried them further. He had no doubt they should have these regenerative furnaces soon in use, and he had hoped that he and his friend Mr. Lane might have introduced them at Cork; but there they had a solid limestone foundation, and if they had to get down a certain depth it meant excavating in solid rock.

The President said it was not necessary to ask Dr. Siemens to reply to the inquiry of Mr. G. Anderson, because that gentleman had apparently misapprehended the object of these furnaces, which was not the production but the reduction of the carbonic acid. They might congratulate themselves that this question, although of very recent importation, had already taken firm root among them, and he hoped the result would soon be made apparent in the wiping off of that reproach to which Mr. Livesey had referred, and the placing themselves upon a level, at the very least, with Continental practice.

Mr. F. Livesey, in reply, said he quite agreed with the sentiment expressed with reference to Dr. Siemens. There was no doubt whatever that to him belonged all the credit of the invention of the regenerative furnaces. Dr. Siemens said that they effected a saving of only 25 per cent., whereas they should have more; but he (Mr. Livesey) must remind them that the arrangements he described where not perfect by any means, and no one was more aware of this than himself. For instance in this arrangement the air was heated underneath the bottom retort which was generally the coolest one in the bench, and, of course, if heated under there it might take heat away from it, so cooling the coolest part of the retort setting; but notwithstanding this they were able to keep the bottom retort sufficiently hot to carbonize the coals, and also to effect a saving of 25 per cent. of fuel. With regard to clinkering, in the second arrangement described they found there was no hard clinkering formed, and after the furnace had been at work for three months, it had not burnt away at all, the only clinker formed being from the coke, which was very friable, and could be picked out with an ordinary tool by a man attending two or three times a day. There was no large hard lump of clinker, as in ordinary furnaces. The steam kept the bottom of the furnace very cool, and the only portions at all burnt were the corners of the bricks which formed the steps. In future it would be put in as a smooth surface instead of the bricks being stepped back. It would be much better if the air could be heated by the waste heat, instead of taking it away from the retort setting. Dr. Siemens had very properly corrected him in saying that the water improved the draught. He meant to say that steam would improve the draught, not water. The water would only decrease the temperature at the grate, and give combustion higher up, where it was more needed. Mr. Hunter referred to the size of the works where these furnaces could be used but he did not think this had anything to do with the adoption of the plan. It was perhaps more easily worked out in a stage retort house, although they were now trying on the floor. All that was necessary was to make a few steps down in front of of the furnace, so as to get it a little deeper. If the retort settings were a little higher there would then be no necessity for this. In reply to Mr. Anderson, as to the use of breeze, he might say they were able to use a small proportion, but it would be impossible to get any air through a mass of breeze 3 feet thick and 4 or 5 feet wide.

Mr, Stevenson said there seemed to be a little misapprehension on the part of Mr. Anderson as to the action of these furnaces. The furnace was designed for the purpose of preventing the primary formation of carbonic acid in any quantity. There was a primary formation of carbonic acid just at the lower part of the furnace, but the gases of combustion passed through so great a depth of fuel in the body of the furnace that in coming in contact with the carbon of the fuel they became reduced to carbonic oxide—the coke was partially consumed, and the carbonic acid became reduced. The

reason of the saving was explained in the paper, that the gaseous fuel could be so much more intimately mingled with the atmospheric air necessary for its consumption than solid fuel could; and therefore the quantity of air necessary for the complete combustion of gaseous fuel would be very much nearer the theoretical quantity than that required for the combustion of coke or coal. Breeze could be used in the Liegel furnace, and in any regenerative furnace, in certain quantities. He would not say that they could use all that was produced, but very little would be produced. There seemed to be some idea that there was an attempt on the part of these German gas managers to wrest from Dr. Siemens the credit of being the inventor of the regenerative principle, but this was not the case at all. It was only just to say on their behalf that there was no question whatever that Dr. Siemens was the inventor; in fact, as had been stated, it received its name from him. But a man like Herr Liegel was entitled to the full credit of having worked out an arrangement like the one described, even if it were like something Dr. Siemens had worked out in early days, and he (Mr. Stevenson) was quite convinced that it had been worked out almost as a new invention. One of the obstacles to the introduction of this principle into small gas works would be that in any form whatever the regenerative furnace cost more than the ordinary one, and some of the few questions put to him when inquiries were made about it was, what would be the proportionate cost? This he was not at present prepared to state, or he should have mentioned it in his paper; but it was so far reasonable that in a comparatively short time the furnace would repay its extra cost. It could be appled in any sized works, and the majority of those using it in Germany were very small works. Those employing Oechelhausers were considerably larger. He did not know any besides the Paris Gas Works, which were very large, that used the complete Siemens furnace. Mr. George Livesey said the principle was still in its experimental stage, but he must differ with him as to that with regard to the Liegel furnace. It might not be complete, but it had been worked out, and had been used in its present form for several years. It might be experimental in England to this extent, that if new works were being constructed the engineer, as he had had no experience of it, might hesitate to put it in at first starting, lest from the inexperience of workmen some failure might result; but this would not be on account of the furnace itself being in an experimental condition. — *London Journal of Gas Lighting.*

Gas and Gas Making.

By L. P. Gratacap, Ph.B.

THE PRODUCT.

Illuminating gas is a mixture of gases whose separate percentages in the whole vary with the material used, and the degree of perfection to which the process practically attains. We are considering gas made by the destructive distillation of coal, and no modification of this process, as coal gas mingled with oil gas, or any novel practice, as water gas. These are reserved for separate treatment.

The ordinary constituents of coal gas and their quantitative relations are shown in the following selected analyses.

Dr. Kidder's theoretical composition:

Hydrogen	44 to 48
Marsh gas	34 " 38
Carbonic oxide	5 " 7
Carbonic acid	1 " 3
Air	1 " 3
Water, temperature 40° to 60°F	1 " 3
Hydrocarbons	6 " 10

CANNEL COALS.

	Manchester Gas.	Rochdale Gas	London Gas.
Hydrogen	45.58	53.44	35.94
Marsh gas	34.90	29.87	41.99
Carbonic oxide	6.64	5.86	10.07
Carbonic acid	3.67	——	1.19
Oxygen	——	——	——
Nitrogen	2.46	——	——
Hydrocarbons	6.46	10.83	10.81
Sulphuretted hydrogen	0.29	——	——

BITUMINOUS COALS.

		London Gas.
Hydrogen	50.05	51.24
Marsh gas	32.87	35.28
Carbonic oxide	12.89	7.40
Carbonic acid	0.32	0.28
Oxygen	——	——
Nitrogen	——	2.24
Hydrocarbons	3.87	3.56

WESTMORELAND COAL ENRICHED WITH ALBERTITE, NEW HAVEN, 1869.

Hydrogen	42.47
Marsh gas	46.16
Carbonic oxide	2.08
Carbonic acid	——
Air	2.68
Hydrocarbons	6.67

HEIDELBERG GAS.

Hydrogen	44	46.2
Marsh gas	38.4	34.02
Carbonic oxide	5.73	8.88
Carbonic acid	4.23	3.01
Oxygen	0.37	0.65
Nitrogen	——	2.15
Hydrocarbons	7.27	5.09

BOSTON GAS LIGHT COMPANY.

Hydrogen	43.15
Marsh gas	42.97
Carbonic oxide	6.06
Carbonic acid	0.35
Oxygen	0.13
Nitrogen	2.05
Hydrocarbons	5.29

In addition to these ingredients, obscure compounds of sulphur with bisulphide of carbon and ammonia salts are found in the gas, and may in large quantities prove highly objectionable and mischievous. Illuminating gas is therefore composed, first, of a series of non-illuminating but highly combustible gases, which together form a burning fluid whose sole office is the supply of heat; second, a group of hydrocarbon gases, yielding upon combustion more or less light; third, diluents whose influence is deleterious directly proportional to the percentage present; fourth, impurities.

The first group consists of hydrogen, marsh gas, and carbonic oxide, and upon the proportions of these bodies present in the gas depend some important features. They regulate the degree of heat which the gas attains in burning, and they determine its density in a great measure. Hydrogen, the lightest gas known possesses the highest calorific power, and while it assists the buoyancy and vitality of the gas, produces upon combustion a high temperature which, as we subsequently see, is essential to the purest and whitest light. Its gravity compared with air is 0.693, its calorific power 34,462 units, and its calorific intensity is 2,746°C., the latter falling so much below the former, since hydrogen in burning unites with the oxygen of the air, which supports its combustion and forms aqueous vapor, and a certain amount of heat is abstracted from the sum total of heat generated in order to raise the temperature of the water produced.

Hydrogen from its calorific power is pre-eminently valuable in gas, and its percentage in normal coal gas should exceed that of any other constituent. Not that it may not predominate so as to virtually destroy or effectively diminish the luminosity of the gas, but that within reasonable limits it enables the engineer to utilize his illuminating material in the best way. The principle underlying this is the much-discussed, some time discarded, and recently rehabilitated doctrine of photogeny propounded by Sir Humphrey Davy. This philosopher insisted that the luminosity of a gas flame was due to the presence in infinite numbers, confined to the luminous zone, of solid points of carbon which became incandescent at high heats. So far as gas flames are concerned this is unquestionably true, and the appearance of soot upon a cold object pressed into a flame, the opacity of the flame itself, at least of its light-giving portions, and the ease with which a non-luminous flame can be made luminous by the introduction into it of coal dust, all point, and, so far as it is a practical question, establish the reality of this theory. Granting this position, there is very evidently a proper proportion to be maintained between the heat produced by combustion of a gas flame and the number of carbon points to be raised to whiteness by that heat. This heat may be obtained by the intimate mixture of oxygen with the flame, and by a large proportion of hydrogen and highly heating bodies which upon burning produce the necessary temperature. The significant conclusions to be drawn from this will be shown further on. It only here indicates the indispensable service rendered by hydrogen in the economy of illumination.

Hydrogen, while it thus, *par excellence*, renders the flame a hot one, imparts lightness to the gas, which permits the engineers to use a reduced pressure for its distribution. Hydrogen, as the lightest body known, diffuses with great rapidity, and a change in the constitution of the gas may take place in long transits from its escape through crevices and minute apertures, and this quite independently of its associates in the gaseous mixture which, although they suffer transfusion, do so in relatively smaller volumes as their density is greater. The well known experiments of Dobereiner and Graham

upon the diffusion of gases showed that through the finest cracks in the walls of a vessel, even though pressure was exerted by the confined gas, the gas will escape and air from without penetrate in its turn within the vessel. The injurious dilution of coal gas by atmospheric air may occur in this way in the works, or out of them in the mains, the lightest elements of the coal gas effecting their escape first and with the greatest rapidity.

Although this consideration has a theoretical value, practically it is not of frequent importance, as leakage of gas from mains, etc., is generally a process of effusion, whereby the gas pours out in an almost homogeneous mass. Marsh gas is the second member of the heating gases; its gravity is 0.557, its calorific power 13,063 units, its calorific intensity 2,630°C. It thus presents a marked contrast to its companion, although it is a non luminous gas excepting a few candles of light claimed for it, and assists in raising the temperature similarly as hydrogen. It is, however, its gravity which renders its presence useful in the coal gas type of gases. It gives body to the gas, a definite weight and texture. It is true we could have a gas in which the burning fluid was wholly hydrogen, and the necessary gravity supplied by increased proportions of hydrocarbons, which would likewise overcome its high heating power, but in the actual economy of coal gas manufacture. hydrocarbons are not abundant, and the marsh gas protects them from a too sudden and complete destruction in so hot a flame as we would have were hydrogen substituted for it, while it makes the gas more manageable to the engineers and more serviceable to the consumer. Marsh gas should not exceed the hydrogen, and should, in fact, be regarded rather as a preservative element than a directly useful one in the gas, where, if its presence is excessive, it raises the gravity of the gas, which in turn necessitates increased pressure, and that reduced luminosity unless compensated for by more or richer hydrocarbons. Neither is it desirable to have it sink below thirty per cent., as in the average percentage of hydrocarbons, its replacement by hydrogen would seriously affect the proper combustion of the latter, as well as inducing costly and needless expenditure of gas by the consumer.

Carbonic oxide concludes the list of heating gases. Its gravity is 0.967, its calorific power 2,400 units, and its calorific intensity 1,975°C. It is a heavy and a highly heating gas. Carbonic oxide may be considered an adventitious member of coal gas constituents, and essentially is of no service. It is rather a necessary accident of gas making than a desideratum. The engineer must endeavor to reduce its percentage as low as possible, replacing it with hydrocarbons or marsh gas. Were marsh gas absent carbonic oxide would serve its purpose, securing by its gravity just that stability for the gas which it is the office of marsh gas to supply. Further, it abets the heating power of the hydrogen, and it thus enables the engineer to increase the hydrocarbons and obtain a higher candle power for his gas.

In water gas it actually plays the same role as marsh gas in coal gas, and in the former marsh gas may be regarded as an accidental and undesirable event, just as the presence of carbonic oxide in coal gas is considered detrimental. Its poisonous properties are well understood, and on sanitary grounds its presence is obnoxious. In reality it is the only organic poison in coal gas, the other gases permitting inhalation, though of course devitalizing and injurious.

In experiments made by the writer upon a gas containing small quantities of carbonic oxide, and upon a gas heavily charged with that body, the rapidity with which death ensued upon the introduction of a rat into the latter over that in the former was nearly proportional to the respective percentages of carbonic oxide in both. Carbonic oxide may help to keep up the heat of a flame where for some reason the marsh gas is excessive in a coal gas, but a large proportion indicates aberrant working. It may very frequently arise from the most mischievous of causes, viz., the admission of furnace gases into the retort with atmospheric air toward the end of a charge where high exhausts are used or where the retorts are old and cracked. The carbonic acid thus sucked in and that formed in the retort is converted to carbonic oxide among the incandescent coke. Of course any such accident causes a widespread derangement of the proportional parts of all the constituents, and destroys the balance of the gas.

Of these gases, two, hydrogen and carbonic oxide, are formed towards the middle and end of the charge at high heats, while the marsh gas is produced at the very first. In an analysis of the process of distillation previously given it was shown that the illuminants passed off first from the charge and were followed by the thinner gases. The actual result of experiments shows this as follows, the table being an average of Dr. Henry's experiments in five different gas works:

	Sp. Gravity.	Hydrogen. Gas.	Marsh	Olefines.	Carbon Monoxide.	Nitrogen.
1st hour	0.633	8.3	70.8	12.3	5.8	2.7
5th hour	0.500	21.3	56.0	7.0	11.0	4.7
10th hour	0.345	60.0	20.0	0.0	10.0	10.0

The same fact is also very well shown in Erdmann and Komhardt's experiments on the varying gravity of the gas during six successive hours after the change was made:

	Hours after Commencement. Specific Gravity. 1	2	3	4	5	6
Erdmann	0.6	0.52	0.43	0.37	0.37	0.3
Komhardt	0.416	0.397	0.353	0.282	0.24	

The second group of gases into which we divide coal gas is that of the hydrocarbons, those high compounds of hydrogen and carbon which impart light to the gas flame when properly burnt, viz., not over or under burnt. These gases are olefiant gas, C_2H_4, propylene, C_3H_6, butylene, C_4H_8, acetylene, C_2H_2, allylene, C_3H_4, benzine vapor, C_6H_6. The principle involved in their supply of light is similar to that in the process by which carbon is deposited in the retorts. At a high temperature these carbons become dissociated, they fall apart into marsh gas and vapor of carbon, and this latter forming a veil of minute points is raised to incandescence or a lower heat by the combustion of the other gases and emit light until destroyed and burnt up into carbonic acid.

The necessity indicated above for a high temperature is shown here, first, because it rapidly decomposes the hydrocarbons, and from certain theoretical considerations probably produces a vapor whose carbon particles are more minute than would result from dissassociation at a lower temperature; and, secondly, because the intense heat as rapidly brings them into incandescence. A subsidiary benefit is also gained, since the marsh gas which results from the falling apart of the hydrocarbons, as is well known, if withdrawn from air, decomposes into hydrogen and carbon, and this may also partially take place within the gas flame. It is obvious that were a gas so highly charged with hydrocarbons that the flame became overcrowded with carbon vapor so that the heat would be insufficient to raise it to whiteness, then the light would in consequence become orange or red. The importance of this consideration, as to the high heat required in a gas flame for its best and most satisfactory appearance, is based then upon, first, the belief that the light arises from incandescent particles of carbon; second, that high heat more instantly and, so to speak, more diffusely, splits up the hydrocarbons into simpler elements. As a corollary from this last hypothesis we say the illuminating power of two flames is proportional to the number of their radiant particles at a high heat. In other words, light results from collective mass and velocity; the atoms supply one, the temperature the other.

Although the reality of this explanation of the luminosity of flames in general has been called in question, not altogether without reason, yet there seems little cause to doubt that in the case of the gas flame it is entirely just. Carbon is certainly separated, and although in a gas flame the soot deposited on a cold surface is not absolutely pure graphite, practically it is so. That collected by Stein upon a silver vessel sunk two to three millimeters in the flame of a slit burner, gave a trace of a solid yellow body when treated with benzide, while alcohol and alcoholic alkalies and diluted sulphuric acid extracted nothing. This soot when washed gave—

Carbon	96.444
Hydrogen	1.051
Ash	0.97
Oxygen	1.533

The oxygen is supposed to arise from water yet clinging to it, removing which, and disregarding the ash, we may write the composition as C 99.095, H 0.905. This body, which is virtually pure carbon, added to a hydrogen flame makes the latter luminous, and exactly similar conditions in the flame from which it was abstracted force us to conclude it was the cause of the brilliancy of the latter. In true coal gas the olefiant gas exceeds the other hydrocarbons. But heavy tar vapors exist in well purified coal gas along with the hydrocarbon gases in almost imperceptible quantities, but to an extent sufficient under some circumstances to be annoying by their settling and aggregation in meters, elbows, etc. Naphthaline, a solid hydrocarbon, may be extracted from almost any gas by passage through a glass tube under ice, stuffed with thin discs of tin perforated by a sieve of fine holes. Gas which previously may not have been suspected of containing this crystalline substance yields it upon such treatment. The writer has obtained small groups of naphthaline crystals encircling the holes made in the tin discs. The presence of solid or semi-solid bodies in gas, as a rule, is objectionable; they burn slowly, are indeed apt to flit through the flame, escaping complete ignition, and they absorb heat, while they disturb the smoothness of the flame in their sparkling transit; and in one case known to the writer, irritated weak lungs breathing the air they filled. These hydrocarbons are not supposed to be all produced in the act of distillation, or if so not to remain unchanged. For instance, Berthollet has devised a theory of mutual interaction, by which new bodies are formed or old ones replaced or dismembered at high heats within the retort chamber. Thus this author found in the Paris gas:

Benzine (in vapor), acetylene, ethylene, propylene, allylene, butylene, crotonylene, terene, and their polymeres, all of which he regards as formed from the four fundamental hydrocarbons, acetylene, ethylene, dimethyl, and methane, along with hydrogen.

The third group is composed of nitrogen, a heavy, inert gas making up four-fifths of the atmosphere, and due to admixture of air when found in large quantities. This gas should not exceed three per cent. in the gas, and even at that it is incontestably due to air. It is true that coals will yield nitrogen, but this is limited to a small quantity only ; and it has been, with some reason, questioned whether any nitrogen can be evolved from the distillation of the coal, except what has been entrapped as air in the interstices of the charge and pores of the coal. The nitrogen increases its gravity without bestowing any compensating advantage on the gas, and in addition adds its own useless volume to be heated up to the point of the other combustible gases. It does not burn, but absorbs and wastes the power of the flame by reason of its high specific heat.

The fourth group embraces oxygen, carbonic acid, sulphur and ammonia. Oxygen enters the gas in the air, which effects admixture with it and is regarded as a sure indicator o the latter. The oxygen of the original volume of air which was introduced in the gas is destroyed by union with carbon, appearing in the gas as carbonic acid and carbonic oxide. The immense detriment, generally speaking, exercised by the oxygen upon the gas, will be alluded to further on in relation to the principle it involves. The actual loss of light effected by the presence of air in gas is by no means a settled matter. Messrs. Audouin and Berard, in examining this question, reported "rather more than six per cent. loss for each one per cent. of air added to the gas, reaching a total loss of 80 per cent., with 15 per cent. added."

Mr. Carl Schultz concludes from experiments that when "coal gas is mixed with atmospheric air its illuminating power for all five feet burners is reduced in the proportion of half a standard candle to every per cent of air present," and "that, this loss being constant, the percentage of aggregate loss will vary with the illuminating power of the gas used."

Silliman and Wurtz examined this question, using the gas of the Manhattan Company of New York, in 1869, and the following schedule shows the results :

Volume of Air Added.	Candle Power Before Addition.	Candle Power After Addition.	Loss of Candle Power.	Percentage Loss of Candle Power.
1.05	15.12	14.20	0.92	6.08
1.82	14.67	13.27	1.40	9.54
2.25	14.71	12.96	1.75	11.82
3	14.81	12.49	2.32	15.69
4.95	14.81	11.28	3.53	23.83
11.71	14.81	8.67	6.14	41.46
16.18	14.81	6.29	8.52	57.53
20.76	15.09	4.09	11	72.9
24.68	14.11	2.18	11.93	84.55

These experiments show that in the case in hand. "for any quantity of air less than five per cent. mixed with gas, the loss in candle power due to the addition of each one per cent. is a little over six tenths of a candle ; above that quantity the ratio of loss falls to one-half of a candle power for each additional one per cent. up to about 12 per cent. of air ; above which up to 25 per cent. the loss in illuminating power is nearly four-tenths of a candle for each one per cent. of air added to the gas."

It is at any rate certain that the admixture of air in a gas will produce varying results, according as the luminiferous richness of the gas itself varies, and the poorer, thinner gases will always suffer the most from such deterioration. Carbonic acid being itself the product of combustion, cannot of course assist the flame, and only withdraws heat ; but in addition, in rich gases, it undergoes decomposition into two volumes of carbonic oxide by reaction upon the incandescent carbon points, and any considerable quantity will seriously affect the illuminating power of the hydrocarbons in this way.

The current statements as to the effect of carbonic acid upon the illuminating power of the gas are as much in need of correction and modification as those in respect to air, for in respect to both their effects change with the character and constitution of the gas affected.

Sulphur in purified gas is usually there in the form of bisulphide of carbon, sulphuretted hydrogen, sulphide of ammonium, a sulphocyanide, and hydrocarbon sulphurets. It has long proved a *bete noire* to English gas engineers, and we have already shown the discussions and discoveries its presence led to there. The American coals are less contaminated with sulphur, and with proper lime purification there should be no difficulty in conforming to the standard of a maximum of 20 grs. of S in 100 cubic feet of gas. In the flame, especially in poor gases burning under a high pressure, it is burnt into sulphurous and sulphuric anhydrides, which, driven into the air of a room, vitiate it, and corrode and destroy metallic objects and delicate tapestries. Many writers and engineers deride the alarm felt about the presence of sulphur in gas, and ridicule the institution of any fixed standard. There has, no doubt, been gross exaggeration of the evil effects of sulphur in street gas, but when a gas gives a reaction on test paper for sulphuretted hydrogen, there can be no question as to its insanitary character ; and gases in which are found from 30 to 40 grains of sulphur in 100 cubic feet, usually contain that poisonous body.

Ammonia in gas is considered objectionable because it may form in combustion acid compounds of nitrogen, though in gases filled with sulphur it in part neutralizes the sulphur acids. It is not a very hurtful ingredient in the gas, but is a useless body ; is more desirable in the gas liquor than in the gas flame, and sometimes is an index of abnormal working, insufficient washing, or poor coals.—*Sci. Am. Supplement.*

The Great Gas Explosion in London.

Through the courtesy of Mr. T. F. Rowland we are furnished with the following, from the London *Standard :*

The inquiry into the cause of the death of Alfred Beavis, aged 50, and William Burr, alias Wicks, aged 21, the two workmen in the employ of the Gas Light and Coke Company, who were killed on Monday evening, July 5, by the Bursting of the gas main at the junction of Bailey street and Tottenham courtroad, was opened yesterday at the Spread Eagle Tavern, Mortimer street, adjoining the Middlesex Hospital, by Dr. Hardwicke, the Coroner for Central Middlesex.

Mr. Besley appeared on behalf of the Gas Light and Coke Company ; Mr. Webster, Q.C., for Messrs. Aird and Lucas, the contractors who laid the pipes. Mr. Robert Willis and Mr. Sampson, solicitors, represented several of the injured persons.

Mr. Webster said that on behalf of the contractors, for whom he appeared, he desired to say that the fullest possible information at their disposal would be forthcoming. He need scarcely say that, whatever caused the explosion, he wished to express his great regret at what he believed was an accident unprecedented in gas working.

Mr. Besley, for the Gas Company, said the same applied to them, as they were most anxious that the thing should be sifted to the very bottom. Plans would be provided for the jury, and the chief inspector of the Gas Company, Mr. Hersey, would attend them to the scene of the explosion and explain all details.

John Burr, 11 Elizabeth street, having identified the deceased, William Burr,

Mr. Herbert A. Smith, M.R.C.S., L.R.C.P., senior house surgeon of Middlesex Hospital, deposed to receiving deceased on Monday evening, suffering from severe collapse. He died the same night. He had compound fracture of the right thigh, fracture of right leg, contusions and burns from the knee joint to the abdomen, and scalp wounds. Amputation of the right thigh was performed, but the patient sank immediately after it. The deceased man, Beavis, was brought to the Hospital about the same time as Burr. He was then dead. There was a contused fracture of the left thigh, and fracture of the leg. He was also in such a burnt and charred condition as to be almost unrecognizable.

Mary Jane Day, Crescent Lodge, Spring grove, Kingston, identified the body of the man who had been spoken of as Beavis, to whom she was engaged to be married.

William Hughes, 9 Edward-cottages, Canonbury, deposed :—I am foreman in the employ of Mr. John Aird, and have been so for seven years. I have been engaged in excavation work and pipe laying all my life.

What were you doing on Monday ?—We were making a connection between an 18-inch main and a 36-inch at the bottom of Montague street. That was completed at half-past five by Beavis and Burr. Nothing happened there.

What did they do next ?—They came to chip the head out of the 36-inch main outside the Bedford Head Hotel.

What had they to do ?—Cross-cut the connection out of the new main.

What was that ?—The lead joint. It was previous to putting in a connection.

Where were you at the time ?—I was with them until they were killed.

What was going on ?—They were cutting out the lead joint, and I was standing on the top of the pipe.

What did you observe ?—We took the gauge off. There was no pressure in the main.

Was anything removed ?—The gauge was taken off after seeing if the pipe to Howland street was sound.

How long had the pipe been laid ?—Three months.

Was gas admitted to the pipe ?—No, sir.

After removing the gauge what took place ?—I applied a light to the half-inch stand-pipe as a precaution before removing the cap to see if it was safe.

What light was it ? –A common lucifer. Burr took it out of his pocket.

What took place ?—A moment elapsed, and then the explosion took place.

Did any light come out ?—No, sir.

Did any go in?—No, sir. I said to Beavis, "It is all right; we shan't require the bag?"

You mean the bag inflated in the pipe to stop the gas?—Yes.

What occurred after using the light—how do you describe it?—I was standing on that portion of the pipe running westward. There seemed a rumbling noise, and then the cap blew out.

What then?—It killed both the poor men.

Was there a great noise besides the rumbling?—Yes; the men were blown up against the other pipe. One of them, Beavis, was blown about 24 feet up the pipe. I fetched him out. Burr was lying outside groaning. I spoke to him, but he did not answer.

What next took place? I thought it was all over, and went up the pipe. I afterward heard that other explosions took place while I was in the pipe. The two men were taken to the hospital by the police.

Mr. Besley.—You can tell me—how far was it eastward from the pipe before you came to a "live" main?

Witness.—About a mile and three-quarters; at Goswell street, where it shut off with a valve and a cap on it. It is bolted on by a flange.

So there is no flow of gas from the live main into the dead one?—No.

The making connection you speak of is not filling with gas?—No, it is only getting ready. For the purpose of making the connection the men had to cut out the lead. A pressure gauge was put in to test whether the joints westward were sound. That gauge was on a small pipe.

How far do you go westward to get to a live main?—About a quarter of a mile. At Howland street.

There was no gas coming out of it, because it was trapped?—It was stopped with a valve, the connection being made.

By the Coroner.—That valve is broken, but the jury can see it. There was no gas in the main eastward, as that was disconnected altogether.

Describe the condition of the pipes westward after the explosion.—They were blown up in several places right out of the ground. There was no damage eastward. I went round eight or nine minutes after the explosion. In Percy street I found a small 4-inch main leaking that had been disturbed, and I stopped it, as I did another at Charlotte street. Two laborers were with me, and I stopped the leakages with clay. We eventually succeeded in stopping all the service mains that had been broken. The lights had been put out by the explosion.

David Winslow, Peartree street, Goswell road, examined:—I have been a foreman of mains about 15 or 16 years. in the employ of the Gas Light and Coke Company. I had to inspect the work done by Mr. Aird, the contractor. That was begun at Goswell road in February, and proceeded to Bailey street. The pipe was laid to Howland street at the same time. The last witness was employed under me. I examined the work daily, and reported to my chief inspector. Everything was satisfactory. I was at the scene of the accident at five o'clock on Monday, when the men were about to cut out the plug. I believed there was no gas in the pipe, which was shut off with a valve at Howland street. I first heard of the explosion in the evening at Goswell road, and came up at once.

By a Juryman.—I had the supervision of a part of Charlotte street to Howland street.

Dr. Hardwicke.—Are you sure there was no leakage at Howland street?

Witness.—Yes; I tested it a week before, and there was no smell.

Have you any idea how the gas got into the pipe?—None at all. There is another foreman named Macarthy, who had charge of some of the job.

Thomas Charles Hersey, 148 Goswell road. I am the chief inspector of the Gas Company. I have been a gas engineer for 20 years. I am well acquainted with the laying of the pipes which were being put in under my supervision by Mr. Aird. It should have been completed on Tuesday.

When were you present last?—I was there on Wednesday. It was all ready for the connection to be made the following day. The west end was plugged.

A Juryman.—What was that for?—As a matter of precaution. We always do that, in case of anybody touching the valve and gas coming into the pipe. I saw the valve put in, and I am satisfied it was perfect.

You have no doubt there was gas in the supposed dead main?—None. The most explosive mixture is one of gas to ten of air, but 5 per cent. will blow up. The evidence given you here is correct.

Can you account for the explosion?—I have no proof.

What is your theory?—It is possible the gas may have got into the new main from a fracture between Bailey street and Howland street in Percy street.

You think some gas may have got in in the length?—Certainly.

Where from—From a leakage in the small main that was charged, but in no way attached. We have leakages every day in some parts of the system. There is considerable loss from that source every year, but I cannot say how much. When there is a leakage the ground smells of the gas. We never put lights to those places, though the ground has been lighted by accident. Sometimes the striking of a pick on a stone will ignite the gas. I have no proof whatever of there being any gas in the main, though there must have been some.

The foremam, Hawkes, recalled, said, in answer to the Coroner, that the men were not allowed to smoke while at work. Beavis did not smoke at all, and Burr very seldom.

The Coroner.—You are not sure that your light did not cause the explosion?

Winslow.—I am not.

The Coroner (to Mr. Hersey)—What do you say to that?—I have no idea. The man did right in smelling the main for gas; and as there was no pressure and he smelt nothing, I cannot account for the occurrence.

Winslow (by the Coroner).—The main was not connected with a "live" main, but was shut off by a valve.

The Coroner (to Mr. Hersey).—Have you instituted any experiments as to whether a light will travel through a pipe.

Witness.—I have no experience of it.

You have no doubt the light did travel backward?—I cannot go so far as that. The evidence that I have was that my foreman did not smell any gas. I have no idea how the gas got into the pipe, but there undoubtedly was some there.

By a Juror—Winslow did not apply the light by my instructions.

A Juryman stated that some eight years since, in Tichfield street, an opening was made in a pipe, and an explosion at once occurred, showing that it was possible for a light to travel through a length of pipe.

Mr. Hersey said he knew nothing of the affair referred to.

At this point the jury adjourned to view the scene of the explosion, and the inquiry was adjourned until Tuesday July 13, at one o'clock, at the same place.

[*From the London Journal of Gas Lighting.*]

CONTINUATION OF THE INQUIRY.

The inquiry into the circumstances attending the death of Albert William Beavis and William Burr, who were killed on the evening of Monday, the 5th inst., under circumstances recorded in the last number of the *Journal*, was resumed on Tuesday last, at the Marylebone Court House, before Dr. Hardwicke.

The following evidence was taken:

William Robert Sibley said:—I am a gasfitter, and reside near Tottenham Court Road. On the evening of Monday, the 5th inst., at about three minutes to 7 o'clock, I was passing up Tottenham Court Road, when my attention was called to the pressure gauge on the end of the main in the trench at Bayley street. Three men were in the trench examining round the cap on the main. I observed that the pressure gauge was rather higher than what I thought was usual, and this attracted my attention. I thought there was a good pressure on, but did not make any remarks to anybody. The foreman came out of the trench, unfixed the pressure gauge, and put his hand to the half-inch stand pipe. I do not know whether it was a light he applied, but I thought it was a cap. [Witness identified Hawkes as the man he referred to.] After this there was a loud clap, caused by the cap that was on the main striking the other part of the pipe, and then I heard a rumbling noise, like thunder going away in the distance—a sort of "thud," repeated five or six times. I should think there was an interval of a couple of seconds between each "thud." All the explosions occurred within two minutes. One of the men was picked up in the trench, and Hawkes went up the pipe and fetched out the other man. There was no smell of gas that I could perceive.

By the Jury—I am in the habit of using pressure gauges.

By the Coroner—I have had occasions to try pressure gauges in buildings, but I never think of having more than a 3½ inch pressure on, and this is not sufficient to blow the water out of the gauge. I cannot say whether the water was blown out of this gauge.

By Mr. Vernon Harcourt—I thought there was pressure in the main from seeing the gauge down on one side and up on the other. I was about six or seven feet away from the gauge, and could not see the scale of it clearly.

James Main said—I was looking at the men at work in the trench by the Bedford Head on Monday, the 5th inst. They were cutting the lead out of the joint of the cap of the main. The pressure gauge having been taken off the stand pipe, one of the men struck a match and applied it to the pipe, and directly he did so the explosion occurred. The man who was cutting the joint was driven up the pipe on the opposite side of the trench. I did not hear the other explosions. After the men were brought out of the trench I went to the corner of Percy street, and saw that the road had been torn up.

By Mr. Harcourt—The explosion followed immediately upon the match being applied to the pipe. I saw no flame but that of the match.

Joseph McCartney saidI am a foreman in the service of the Gas Light and Coke Company, and was inspector over the men employed to lay down these

pipes. We commenced the work on the 1st of March. I saw the mains laid from Howland Street, and the valve there was put in by me. It was tested before we received it, as well as upon the spot, and I left it safe and sound. I saw six lengths of pipe laid from it down Charlotte Street, and then I had to leave the work in consequence of the sudden death of my wife. We were working up from Tottenham Court Road to Howland Street. I do not know when the connection was made between Charlotte Street and Howland Street.

By Mr. Besley—I had nothing to do with the eastern section of the main, from the Bedford Head to Goswell Road. The empty pipes on the western section were put down about the 20th of March. [Model of valve produced.] The valve now produced is a model of the patent valve which was put in at Howland Street. In the ordinary course of business the valve is tested by the patentees; then by the gas company at Haggerstone, with water; and again when brought to the job. In order to make all sure we face it with Russian tallow. A cap was put on the valve. I did not notice any particular smell of gas after the valve had been put in, as there is generally a smell of gas when we are altering mains. When I went inside the main to cement the joints there was no smell of gas. On Monday, the first of March, I reported that the valve was in good working order, and that it seemed perfectly tight.

By the Coroner—We had been altering a 12 and an 8 inch main, and the escape of gas I smelt would probably proceed from these pipes; there is sure to be an escape when we have the end of a main open. At one time four companies supplied this district, and the escape, if there was an escape, would be from one of the old mains. I cannot account for the gas getting into the new main.

Mr. Harcourt—Is there any other means you can suggest by which the gas could have entered the main, except through the valve?

Witness—There are a great many things which might be suggested. Supposing there was a fracture in the dead main, and a leakage was taking place from another pipe, the gas would enter the dead main. There could not have been much gas present; if there had been the explosion would not have occurred.

The Coroner—Do you think there was a fracture in the large main?

Witness—I was not there when the main was tested, so that I do not know.

Mr. Harcourt—Have you ever known of a case such as this, in which gas was found to have leaked into a main which had not been brought into use?

Witness—I have; it occurred some time ago in Camden Town, when we were making temporary connections.

By the Coroner—I use a light to test a pipe when I require it, but I can not say what necessity there was for it here, as I was not present. I believe the gas is strong enough to burn.

William Hawkes, the contractor's foreman, was recalled, and produced the pressure gauge he had used on the main. He said: The gauge is always filled with pure water. From the marks on the glass it can be seen where the water stood from Saturday, the 3d inst., to the following Monday; there was no pressure indicated—it was down at zero. If there had been any pressure we should have had to use a bag before taking the plug out of the main. Knowing it was connected with a live main, I took the precaution of trying it with a light. There was a little smell of gas, but no pressure. My opinion is that the gas must have got through the valve. I can not say that anyone had been trying it. If it were opened for a minute a large quantity of gas would pass through. People cannot get to the valve.

By the Jury—I do not believe that the keys of the water mains fit our valves.

By Mr. Besley—The valve was taken off the pipe between six and seven o'clock in the evening. I applied the match directly I took the gauge off. I am quite sure the gauge stood at zero.

By Mr. Webster—I am used to pressure gauges.

By Mr. Willis—I have applied a light to a stand pipe before, and when I have done so the gas, if there was any, has flared but has not exploded. I did not know that air when mixed with gas was explosive. I was not aware of the danger.

By the Jury—I did not smell any gas. The reason I applied a light was because I knew the main was connected with a live main, and therefore I thought I would take this precaution.

By the Coroner—I am now wise enough to know there was gas in the main, and I think that gas got through the valve. It is possible that it might have oozed out of the old mains, but I do not know how it could have got into the new main, because the castings are quite perfect.

Charles Hales said—I am foreman for Messrs. Aird and Sons. I had charge of the laying of these pipes, and it is part of my duty to see that they are perfect, and that the joints are properly made. The pipes are quite an inch thick. I do not see how gas could get into the new main from the old ones. We generally find a smell of gas when we open the ground, but there was not such a quantity in this case as to prevent our breathing properly. Sometimes we find the air charged with gas, but we do not think it necessary to use a safety-lamp. If there is plenty of gas we light it.

By Mr. Harcourt—When laying this main we did not find a leakage sufficient to light.

By Mr. Webster—After the pipes are laid we test them to see whether there is a leakage. This is done by forcing pure atmospheric air into the mains by means of a pair of bellows, and we then watch the pressure gauge in order to see whether any air escapes. I never knew of a pipe being cracked by the pressure of gas. A crack in a pipe before it is laid can be detected by sounding it. None of the pipes in this case were imperfect; not a single one was rejected. I saw that they were all sound before they were put in. I made the connection with the valve, and having tried it I found it to be perfectly safe. After laying seven lengths of pipe from the valve down Charlotte Street, we went to Bayley Street and worked back.

By Mr. Harcourt—After the valve was fixed it was tested with fire, to see whether any gas escaped. The pipes are caulked with yarn, and then from two and a-half to three inches of lead run in. I look at every joint before it is filled in.

By Mr. Besley—The pipes are not supplied by Messrs. Aird; they are supplied by Messrs. Cochrane. There is no motive for putting in a bad pipe. If we found a bad pipe we should send it back.

Mr. William B. Scott, Chief Surveyor for the district of St. Pancras, said—I have been called upon by my Vestry to investigate and report upon this accident, and I have visited the neighborhood in order to see what damage was done to the property of the Vestry. While the main-laying work was going on, the only jurisdiction I had was with regard to the reinstating of the roadway. The contractors and the gas company are bound to give us notice in writing of a trench being filled in, and also of their intention to lay a main. I had notice that certain works were being done within the limits of the parish. The first operation is to sink trial holes to see what obstacles they will meet with in laying such a main as this, and after the main is laid the company give us notice that the road is ready to be reinstated. I have no jurisdiction over the mains or the works, and have not in the present case interfered in any way. I have no power to compel the company to lay the pipes at such a distance below the surface of the roadway as to render them safe from a steam roller. I have never been called upon to express an opinion whether a distance of two feet from the surface might prove dangerous, but no doubt it is an important point. A 36-inch main would only bear a certain pressure, and it might be damaged by a steam roller passing over it. A steam roller is used in some of the streets of our parish, and we have had instances of water pipes being broken by it. I have not formed any opinion as to how the gas found its way into this main.

The Coroner remarked that he thought it would be as well to have evidence as to the preparation of the mains for the reception of the gas.

Mr. Thomas Charles Hersey, Chief Inspector of The Gaslight and Coke Company, said—The means adopted to expel the air from a main when we are about to fill it with gas are very simple. We allow the gas to flow into the main by opening a valve on an already charged main, and the entrance of the gas at one end gradually drives the air out at the other. We had a two-inch pipe screwed into the 36-inch main, and when the connection was made we should have gradually opened the valve at Howland Street and forced the air out at Goswell Street. I should attend to this duty myself, and wait until I found pure gas coming from the pipe. The operation of expelling the air was to have taken place last Wednesday, and would have occupied about six or eight hours; but it would have depended entirely upon how far the valve was opened. In this case I should have done it gradually. When I found pure gas coming, I should have had the main closed.

A Juror—How do you know when you have pure gas?

Witness—We have a small wrought iron pipe, with a cock upon it, and when we smell gas at the pipe we apply a light.

Could you not supply the workmen with some mechanism to test with?

Witness—They have nothing to do with the testing; I do this myself. I am only responsible for what is done by the men under my directions.

By Mr. Willis—Hawkes had no right to apply the light; it was done without orders from me. I object to a light being used in the case of an escape.

By Mr. Besley—We had to remove old gas and water mains during the progress of the main-laying work, but the pipes so removed were properly replaced under my direction. Valves are tested by the patentee before delivery, afterwards at the company's works, and again on the spot before being fixed. When the valve is placed in position, the spindle actuating it is about two inches below the surface of the roadway. On the 1st of March, after the valve was fixed, I told a man to go through the six lengths of main to try it with a light, and he reported that it was sound. The main was then capped, and from that date there was no indication, in any shape or form, of the valve being defective. When we subsequently went to Bayley Street,

and took the cap off the six lengths of pipe, the air inside was found perfectly sweet. I had the cap placed on the six lengths of main laid down from the valve when we stopped the work at that point. I laid a sufficient quantity of main down Charlotte Street to clear the roadway in Howland Street, and we then worked towards the valve from the other end. This was done because some years ago a man who had crawled up a long length of main was suffocated by some gas in it. There is no possibility, now that the accident has occurred, of our being able to give a positive opinion as to whether the valve had been tampered with, it having been blown to pieces by the explosion. I think there is a water-plug close by the valve.

By Mr. Webster—It is our practice to test the mains for tightness, and this main had been tested, and reported sound, on the Friday previous to the accident.

By the Jury—I believe the key of the water-main will fit our valve.

Mr. Harcourt—Can you inform me whether this main had been tested for tightness by air being pumped into it?

Witness—Yes; that was done by Messrs. Aird & Sons, under my superintendence. The pressure was on from half-past eleven on the Thursday morning before the accident till the following Sunday, when it went off; that is to say, the air had leaked out of the main as it always does. If there is a fractured socket in the main the pressure will not rise; but in a large main like this if you can get the pressure up two feet in half an hour, as we did it may be regarded as perfect. We do not expect to have it absolutely tight, because iron is porous.

Have you ever known of a dead main becoming charged with gas?

I do not know of a case.

You say you recollect a man being killed by gas finding its way into a main?—That occurred 20 years ago, when we were laying a main across Hyde Park, and the man, who was cementing the joints inside, was suffocated. In consequence of that accident I would not allow the men to work from the valve in Howland street, but up to it. I do not think the gas that found its way into the new main escaped from the valve; my theory is that it escaped from one of the small mains, and entered through a slight fracture in the large main.

The Coroner—With relation to the diffusion of gases, are you aware that gases will diffuse themselves most rapidly through a small aperature?

Witness—I certainly was not aware of that.

Mr. Harcourt—Is it your opinion that, but for the unfortunate application of a light, all would have gone on in the usual manner?

Witness—I believe so; I have no reason to suppose otherwise.

As to the practice of testing for gas, was it, in your opinion, exceptional that the contents of the main should have been tested in this manner, contrary to the ordinary good practice of laying gas mains?—I do not quite follow that; there was nothing out of the common in what we were doing, so far as practice is concerned.

In applying a light?—I say there was no necessity to apply a light; I thought you were alluding to the testing of the main.

The Coroner—Previous to the air being made to escape in the manner you have described, you think it would not be a proper act to apply a light?

Witness—As I supposed there was only air in the main, I should not have expected to get anything by applying a light. The foreman found there was no pressure nor smell of gas, but knowing that the main was connected with a live main, he informs me that he applied a light as an additional precaution. Seeing that there was no gas in the main, I should not have applied a light.

Mr. Harcourt—If there could not be any gas in the main the test was useless, and if there was any the application of a light would be very dangerous?

Witness—Yes.

This length of main had been closed for nearly two months?—Yes.

During which time it lay in a soil in which gas may have been present, and having at one end a valve which may have leaked?—It may have lain in soil saturated with gas.

The Coroner—Gas was present in the soil?

Witness—Yes; so the foreman Hales states.

Are you so satisfied with the joints of your mains that you think they are unable to be permeated with gas?

Quite satisfied.

Then how is it that the leakage of gas takes place to the extent it does?

Because the mains were not laid so well 20 years ago as they are now. I am perfectly satisfied with the method of joining; it does not admit of external leakage.

Mr. Harcourt—In cases of this kind is it not necessary to test with a light?

Witness—Quite so.

Would it not be possible, by giving stringent instructions to workmen, to prevent the danger attending such testing?

This is a new thing to us.

By the Jury—If 10 per cent. of gas were in the main, it would amount to about 1400 feet. No more than the ordinary precautions are taken to protect the spindle attached to the valve; it is placed in an iron box, but there is nothing to prevent a person maliciously tampering with it. The key of the valve is kept in my office.

In answer to a question put by a Juror as to the power of a light to travel backwards,

Mr. Harcourt said—Until this event, I should have thought it improbable that a light would have travelled down a half-inch pipe into a gas main.

The Coroner said the only remaining point was as to how the gas got into the main, and upon this he should like to have the opinion of an experienced person.

Mr. William Foster said—I am a Master of Arts, and am Prof. of Chemistry and Physics at the Middlesex Hospital. For 2½ years I have been Gas Examiner to the Metropolitan Board of Works. I have visited the scene of the explosion, and have made some investigations on the subject. It is my opinion that the explosion was due to the presence in the main of an admixture of coal gas with atmospheric air.

The Coroner—What are the smallest proportions which you think would form a dangerous explosive mixture, and its maximum.

Witness—The maximum would require about 8 parts of air to 1 of gas; that is the maximum degree of explosive air. Then on each side less air, less explosive; more air, less explosive. One part to 9 parts is a 10 per cent. mixture, and this would be less explosive than 1 part to 8.

When would it begin to burn, and not explode?

I have not made accurate experiments upon that point, but I made a mixture in my laboratory two or three days ago—I think it was a 20 per cent. mixture—which would not ignite backwards, using this 6-foot glass tube, three-eighths of an inch in diameter; but if there was pressure behind it it would burn.

By the Coroner—I have here two samples of mixtures, one being 1 part to 7, the other 1 part to 9. The oxygen of the air is an element of danger; and combined with carbonic oxide, marsh gas and other things, it is dangerous. The sudden combination is the cause of danger. I will apply a light to the tube I have here, and show you that the light will travel back; but with a similar mixture in a larger tube, there will be an explosion. Coal gas is safe so long as it is not mixed with atmospheric air. [Mr. Foster tnen applied a light to a narrow tube, when the the flame was seen to to travel down; but on the the application of the light to a larger tube the gas exploded.] I think in testing mains a proper jet should be constructed if a light is to be applied.

The Coroner—Can you form an opinion as to the means by which the gas in this case found its way into the main itself.

Witness—Only by an aperture in the pipe; it may have been through the valve, or through a fissure in the main itself.

Do you think that the side mains might have leaked to a sufficient extent to form an explosive compound?

Taking the diameter of the main as 3 feet, and its length as half a mile, its cubical capacity would be something like 16,800 cubic feet; and taking the mixture at 10 per cent., it would require about 2000 feet of coal gas to give a similar effect to that which you have just seen produced in one of the tubes. A short time ago I was requested to report on the explosion of a tar tank at a country gas works. A main had been recently laid alongside the tar tank; there was a small man-hole, and coke had been piled on the tank. One day, while a man was emptying a barrow of coke, the whole thing blew up, and when I examined the circumstances, I came to the conclusion that there had been a leakage of gas from the main, and that it had diffused itself through the porous layers of brickwork. It is a fact that gases do diffuse at a certain rate, and through very small crevices—in fact, through what we should call a solid material. They find their way through brickwork and porous substances. The tar-tank explosion was a most typical case.

Mr. Harcourt—You would not include cast-iron and the joints of main among porous substances?

Witness—No; these would only be permeable in certain cases. The joints in this main were filled in with molten lead.

By the Coroner—I have not examined the joints personally, or tried any experiments upon them.

Mr. Webster said the new main was simply intended as a conduit main; there was not to be a single service upon it.

Mr. Besley—This being a conduit main, and 1 inch thick, is it your theory that gas might have diffused itself through the pipe?

Witness—No; that is not my theory; I do not think it is possible. The circumstances of this case are not such as to give any support to the theory. The adjacent gas pipes had been opened from time to time.

The Coroner—While laying down this main, was the atmosphere sufficiently charged with gas to be dangerous?

Witness—I think not.

What quantity of gas becomes unbreathable in atmospheric air? One per cent. would make the atmospheric air very offensive indeed. Carbonic oxide is an objectionable constituent of coal gas.

A Juror—The foreman said he could not smell gas coming out of the pipe?

Witness—I heard from one of the people that there was a slight trace of gas.

Will not 10 per cent. of gas make the air very offensive?—Very offensive indeed.

Mr. Harcourt—I wish to correct a statement I made just now. It certainly was my impression that one would not beforehand have thought that applying a light to a small pipe would be as dangerous as it has proved to be; this depends, however, on the probability of there being air and gas in the main within those limits which would render it not only explosive, but would cause a small pipe charged with the mixture to act as a conductor of the flame downwards into the main. I have made experiments upon these points, and I find that within the limits of 4 of air to 1 of gas, and 10 of air to 1 of gas, the mixture is sufficiently explosive to travel down a tube of the diameter of the stand pipe here.

The Coroner, in addressing the jury, said they had first to inquire into the cause of the death of these two men, and this might be said to have been from injuries received by the explosion. If the jury thought the explosion came under the head of what might be termed an accident, they might, if they thought proper, append to the verdict an expression of opinion as to what should be done to prevent similar accidents in the future. Evidence had been given that undoubtedly there was an explosive mixture in the main, that 10 per cent. of coal gas mixed with air was a dangerous explosive compound, that a light would travel back in a tube of small diameter, and that the men employed in the main-laying work were not aware of the extreme danger they ran in applying a light. It became a question whether the men should not have had some knowledge, and have adopted measures for the safety of the public. He did not know that any blame could be attached to the officials of either the gas company or the contractors, who had been anxious to afford every information, and would, no doubt, do what they could to prevent a similar accident occurring again.

The jury then retired, and after an absence of half an hour, returned into court with the following verdict—"We are of opinion that Albert William Beavis and William Burr met their deaths by an explosion of gas, such explosion being caused by a light being ignorantly placed to a stand pipe by the foreman Hawkes, gas having been introduced into the new main by some defect in the valve in Howland Street. We are further of the opinion that additional care should be taken by The Gaslight and Coke Company in the testing of new mains."

The Coroner—You say "by some defect in the valve in Howland Street." Does the evidence go as far as that? The valve might have been opened by misadventure, and if so the verdict does not cover it.

The foreman—We cannot come to any other conclusion.

Mr. Besley said he did not wish the jury to alter their verdict, but he thought they hardly expressed what they meant. As their verdict stood, it implied that there was some defect in the manufacture of the valve, or that it was put in defectively; but as he understood, the jury meant by a defect of the valve as a valve on the day of the accident.

A Juror said they did not mean to imply that an improper valve had been put in, but that the gas had escaped somehow through the valve.

Mr. Harcourt said the word "defective" was a little ambiguous. A large valve of this kind would not be considered in any sense defective if there was a small leakage; that would be perfectly immaterial, having regard to the purpose for which the valve was intended; but yet such a leakage, going on for two months, into a main perfectly sound, would produce an explosive mixture.

A Juror said they simply meant to say there had been leakage through the valve.

The inquiry then closed.

Gas from a Well.

THE CURIOUS PHENOMENON AT OCEAN SPRAY.

Residents at and visitors to Ocean Spray are considerably exercised over the discovery of what is commonly called a "gas well." Some absurd rumors have been circulated in regard to it, and it will therefore be interesting for the *Herald* readers to know just what has been brought to light.

On July 22 last a well was sunk on the estate occupied by Dea. Reed, between Coral and Trident avenues. After going to a depth of about 125 feet it was noticed that the water was strongly impregnated with sulphurous gas. As the well was sunk close up to the house, it was not considered safe to experiment much as to the burning properties of the gas, so, on July 30, Mr. J. H. Jessop, the owner of the premises, was induced to sink another well on the lot adjoining, a distance of about 20 feet from the well first sunk.

The pipe was driven to a depth of 86 feet, and his anticipations were more than realized. The sulphuric gas came up with such force and strength as to almost overcome the workmen. When a light was applied a flame rose in the air to the height of three feet or more. Notwithstanding that the diameter of the pipe is but two inches, the gas makes quite a loud, hissing noise in escaping, which power is quite remarkable, in view of the circumstance that the water rises to within 12 feet of the ground, giving the gas but a comparatively short free vacuum. Though three days have gone by since the discovery was made, the supply is not diminished, but, on the contrary, seems rather to increase in power and quantity.

It is an interesting question now whether there is an inexhaustible quantity of it, and whether it can be used for illuminating purposes. So far everything promises well. In order to experiment further, another pipe was attached to the opening of the sunken pipe, and laid along the ground a distance of about 15 feet. Then an upright pipe was attached, and a common trunk inclosed in it, in order to shelter the burners from the wind. Several burners have been attached, and when the gas is turned on and a match applied a very bright light is obtained. So great is the force of the gas that care and patience are needed to light it, the power often extinguishing an ordinary lighted match. An ordinary gas gauge was applied to test its power, but no satisfactory results could be reached, as its force was sufficient to throw the water from the tube.

Friday evening from 1000 to 1200 people witnessed the lighting of the gas, and expressed the greatest curiosity and enthusiasm over the discovery. It is believed that this is the first discovery of the kind in the State. In some other States such discoveries are quite common, and it is stated that the city of Erie, Pa., and other places are lighted from sulphurous gas from wells.

It was afternoon when the *Herald* representative inspected the discovery, and consequently he could not form an adequate idea of the brilliancy of the light, though the force or power of the gas was made apparent to him in many ways. No chemist or scientific men have as yet inspected it, but it is thought that the gas is hydro-sulphuric acid or sulphuretted hydrogen, a gaseous compound consisting of two volumes of hydrogen and one of sulphur vapor condensed into two volumes, which form its combining measure. Hydro-sulphuric acid is a colorless gas, has a slight acid reaction, and a most offensive odor, recognized in rotten eggs, dock mud, cess-pools, many mineral waters, and putrefying organic matter containing sulphur. It extinguishes flame, but burns itself in contact with air with a blue flame, depositing sulphur. The gas is noxious to inhale. Hénard found that a small bird will die in air containing 1-1500 part of it, and a horse in air that contained 1 250 part of it. The presence of the gas is detected by its odor, and by its blackening a paper with a solution of acetate of lead. It is the cause of the discoloration of white lead paint in the apartments of houses, also of the blackening of silver spoons when the are used with boiled eggs, the albumen of the white of the egg furnishing the sulphur for the production of the gas.

In order that the gas may be further tested, Mr. Jessop is going to erect a small meter and connect with it a short line of burners. He will also put up a tent to-morrow, and thereafter the public must pay a small admission fee to see the curiosity.

Whether the discovery will turn out to be one of importance is yet to be demonstrated; but, at all events, a most curios phenomenon has been "brought to light," in more senses than one. If the quantity of gas escaping through a pipe only two inches in diameter is so great, what must it be if a pipe four or six inches in diameter were sunk? The fact that the gas forces itself through 74 feet of water would seem to indicate that the supply is great if not inexhaustible.

It is all the more singular that the gas should be discovered within so short a distance of the salt water. Residents there say that previously they have noticed a sulphurous smell, but supposed it arose from dock mud. A well of water on the premises occupied by Mr. Jessop, a short distance from the lot where the gas was discovered, is unusually cold and pure for a well near salt water.

In case that, after sufficient experimental tests, there is found to be an inexhaustible supply of gas, the value of the discovery to Ocean Spray and Winthrop can hardly be overestimated. It could be used for heating, cooking, illuminating, etc., and, in the event of its success, it is probable that a stock company would be formed, and pipes laid all over the town. As the gas comes up through 74 feet of water, it might not be necessary to water the stock. At all events the public, and particularly the residents of that locality, will await further developments with interest.—Boston *Sunday Herald*, Aug. 1.

GAS IS TO BE USED for driving two large engines in the lighthouse at Largness, Isle of Man.

THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

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MONDAY, AUGUST 16, 1880.

Official Report of Examinations of Gas for two Weeks ending Aug. 7, 1880, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

1880. July	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
		†	*	†	‡	*	†
27	Between 9.30 A.M. and 1 P. M.	24.03	19.12	26.92	20.37	18.36	27.63
28		23.16	18.42	27.51	19.16	17.90	27.92
29		22.92	19.60	28.20	19.47	17.70	27.87
30		23.95	19.22	28.44	20.66	16 87	28.22
31		24.68	18.99	28.88	20.47	18.56	28.44
	Average	23.75	19.07	27.99	20.02	17.88	28.01
Aug. 2		23.36	19.00	27.64	21.00	18.33	28.22
3		22 70	19.15	27.14	21.67	18.15	27.20
4		21.90	18.67	26.69	20.68	18.22	27.32
5		20.68	19.40	26.03	20.95	17.94	27.53
6		24.26	18.58	27.04	20.28	17.39	29.51
7		24.54	19.53	26.67	20.90	17.31	28.68
	Average	22.90	19.05	26.87	20.91	17.89	28.07

* Five foot lava tip with check.
† Bray's slit union, No. 7.
‡ Bray's slit union, No. 6.

E. G. LOVE, Gas Examiner.

Fire at Retort and Fire Brick Works.

On July 6th the works of Gardner Brothers were seriously damaged by fire completely destroying their engines and considerable material. The works were in operation again, however, in ten days, and but little delay may be expected in the execution of orders.

Corrections.

OLD ORCHARD BEACH, ME., Aug. 7, 1880.

Mr. Editor:—In the fourth line from the last in my communication in your issue of the 2d inst., the words "Lowe" and "coal" were mi-placed. The line should read—"how much more of coal gas it will take to destroy life than Lowe gas."

In the paragraph referring to the number of deaths which took place in Toronto from the inhalation of coal gas, your printer has omitted the word "one" between the words "and" and "from." The sentence should read—"and *one* from an escape of gas," etc.

Yours truly,
W. H. PEARSON.

American Institute of Mining Engineers.

PROGRAMME OF THE LAKE SUPERIOR MEETING.

Friday, Aug. 20.—Leave New York 8:25 P.M., by Penn. Railroad.

Sunday, Aug. 22.—Arrive in Chicago 8:00 A.M. (Arrangements have been made with the Grand Pacific Hotel to entertain the party at $2.50 each a day, or $3 a day for rooms with baths.)

Monday, Aug. 23.—Leave Chicago at 7:50 A.M., by special train, kindly provided by the C. & N. W. Railway and the M. H. & O. R.R., arriving at Marquette at 9:00 P.M. (Busses leave the hotel at 7:20 A.M.

Tuesday and Wednesday, Aug. 24 and 25.—Visit the iron region.

Wed. Aug. 25.—Leave Marquette by chartered steamer, and arrive at L'Anse at 7:30 P.M., and at Houghton at 11:00 P.M.

Thursday and Friday, Aug. 26 and 27.—Visit the copper district.

Friday, Aug. 27.—Subscription dinner at Houghton at 7.00 P.M. Leave Houghton at 11:00 P.M. and Portage at 12, midnight.

Saturday, Aug. 28.—Arrive at Fort William at 8:00 A.M., and visit Thunder Bay, Silver Islet, and Isle Royale. Leave Isle Royale at 6:00 P.M.

Sunday, Aug. 29.—Arrive at Marquette 6:00 A.M. Leave Marquette 12:30 P.M. Pass Pictured Rocks 7:00 P.M.

Monday, Aug. 30.—Arrive at Sault Ste Marie 4:00 A.M., and pass through Sault Ste Marie Canal and River, and the Straits of Mackinaw, arriving at Mackinaw 6:00 P M.

Tuesday Aug. 31.—Arrive at Escanaba at 5:00 A.M., and visit the Menominee Iron Region. Leave Menominee River Junction at 6:00 P.M., by Chicago & Nort Western Railway.

Wednesday, Sept. 1.—Arrive in Chicago 6:00 A.M. Leave Chicago 8:30 A.M.

Thursday, Sept. 2.—Arrive at New York 6:25 P.M.

The unusual facilities offered to the members of the Institute to visit this most important mineral region, combined with the pleasure of a summer's excursion will, it is believed, render this meeting of the Institute larger in numbers and more interesting than any meeting held hitherto.

Blank forms of proposal for membership may be had from the Secretary for the convenience of those who wish to offer names for election.

Members are requested to inform the Secretary promptly of their intention to read papers at the meeting.

THOS. M. BROWN, Sec.

Lafayette College, Easton, Pa., Aug. 9, 1880.

The Metric System.—The metric system became obligatory on the 15th of July in the kingdom of Spain and all its colonies. The Turkish government has also ordered the introduction of this system into all its provinces, including Tripoli and Arabia. The cubit gives way to the meter in Jerusalem, and the shekel to the kilogram.—*Scientific Press.*

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
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AUGUST 16, 1880.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	*Par.*	*Bid.*	*Asked.*
Gas Co.'s of N. Y. City.				
Central	466,000	50	60	70
Harlem	1,800,000	50	72	77
" Bonds	170,000			103
Manhattan	4,000,000	50	188	190
Metropolitan	2,500,000	100	140	142
" Scrip	$1,000,000	..	100	103
Mutual	5,000.000	100	70	75
" Bonds, gold	900,000	1000	100	—
Municipal	1,500,000	100	175	180
" Bonds	750,000		106	110
New York	4,000,000	100	101	104
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	100	110
Citizens	1,200,000	20	60	65
" S. F. Bonds.	320,000	1000	100	105
Fulton Municipal	1,500,000	100	70	80
Peoples	1,000,000	10	38	42
" Bonds	290,000	...	90	95
" Scrip	250,000	...	75	85
Metropolitan	1,000,000	100	65	75
Nassau	1,000,000	25	50	57
" Ctfs.	700,000	1000	85	95
Williamsburgh	1,000,000	50	70	75
" Scrip		...	98	103
Kings Co	135,000	100	60	70
" Bonds	40,000	—	—	—
Union Co. E. N. Y.		25	—	50
Richmond Co., S. I.	300,000	...	75	80
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N.Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md	2,000,000	100	185	190
" Ctfs., gold	1,000,000		—	103
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	85	90
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.				190
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	114	120
Elizabethtown, N. J.	300,000	20	—	130
Fort Wayne, Ind.		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	120	125
Hempstead, L. I.	25,000	100	...	—
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150.000	40	117½	
Jersey City	750,000	20	155	160
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	100	...
Lewistown Maine	400,000	100	70	80
Laclede St Louis Mo	1,200,000	100	93	96
Long Branch		25	30	40
New Haven, Conn		25	120	140
Peoples, Jersey City		...	50	60
" " Bds.				5
Peoples of Baltimore		25	100	102
" Bonds			106	—
Plainfield, N. J	80,000	100	—	105
Perth Amboy		25	—	95
Pittsfield, Mass			120	130
Rochester, N. Y		50	70	80
" Citizens		100	50	60
Rondout & Kingston			75	80
St. Louis Missouri	600 000	50	300	—
Stillwater, Minn	50,000	50	—	26

Saugerties, N. Y....	15,000	100	95	100
San Francisco Gas-Co., S. Fr'isco Cal.			71	71½
Toledo, Ohio.....			95	97
Troy, Citizens.....	600,000	100	—	—
Washington, D. C...	1,500,000	20	170	185
" Scrip	500,000	20	100	110
Woonsocket, R. I....	150,000	100	80	...
Wilmington, Del....		50	174	...
Yonkers.....		50	—	70
Montreal, Canada....	2,000,000	100	139	140

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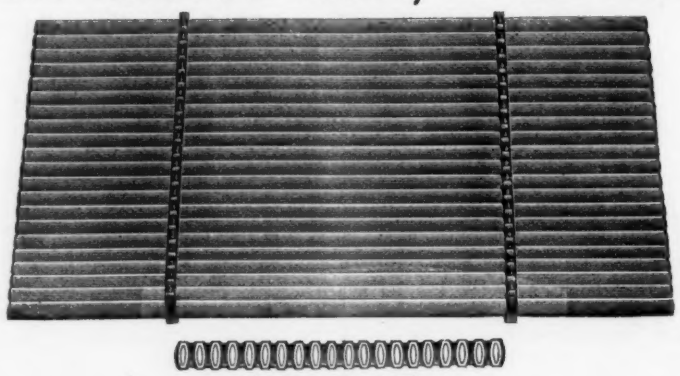

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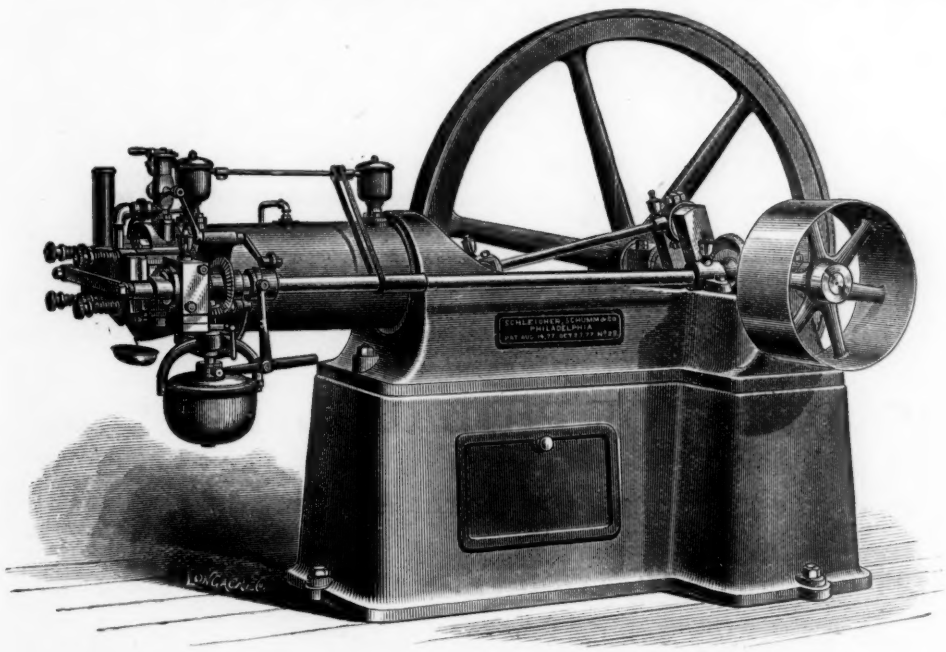

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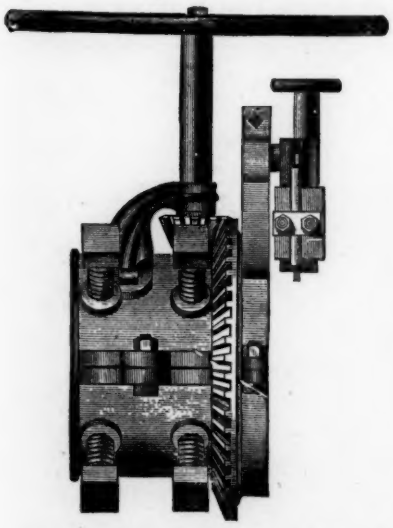

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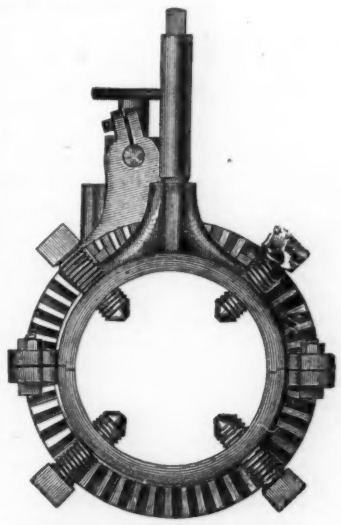

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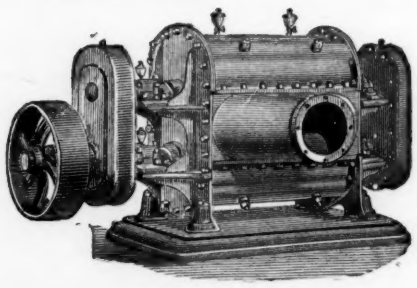

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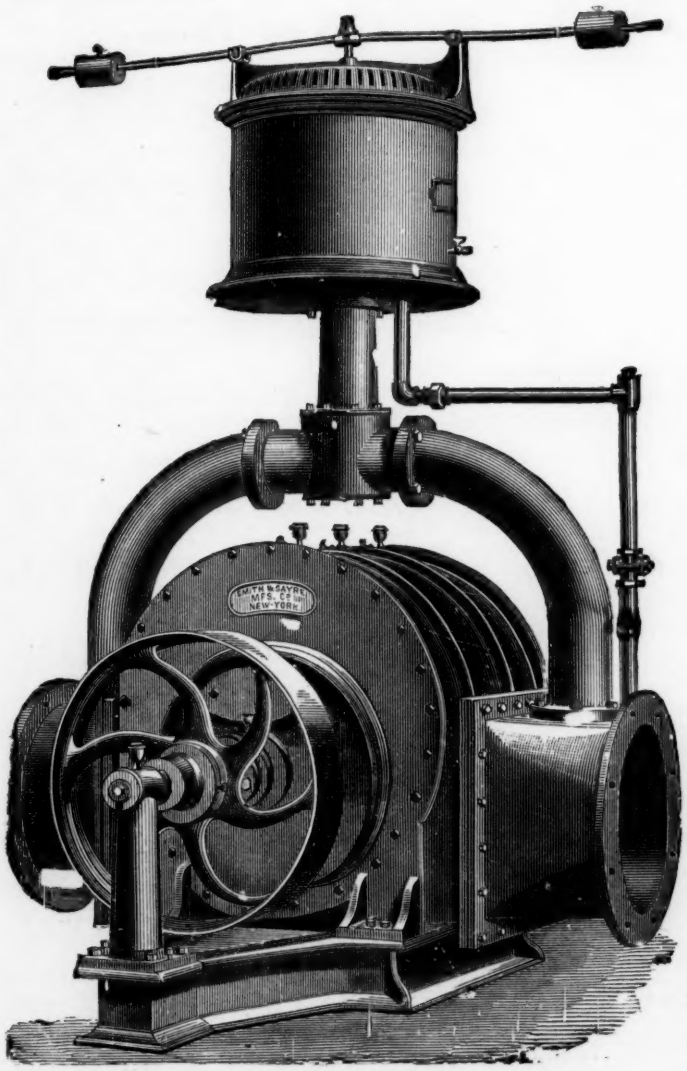

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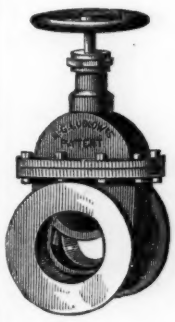

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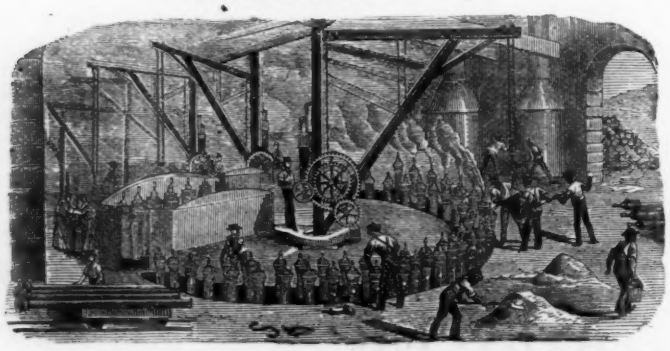

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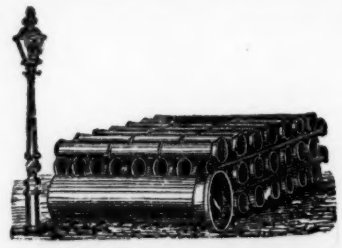

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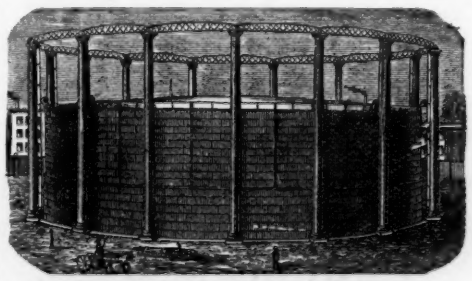

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351-1y

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366-1y

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Attest—J. L. CAMPBELL, Secretary, pro-tem. Signed—A. T. GOSHORN, Director General J. R. HAWLEY, President.

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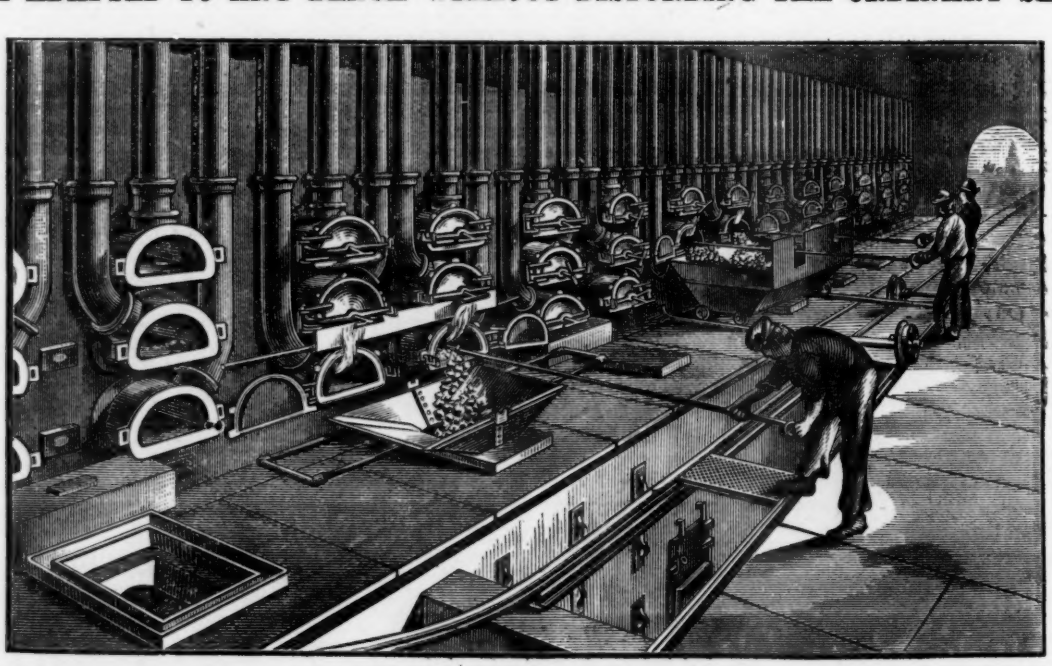

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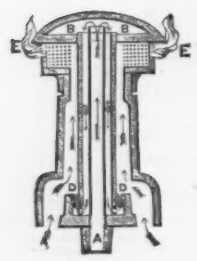

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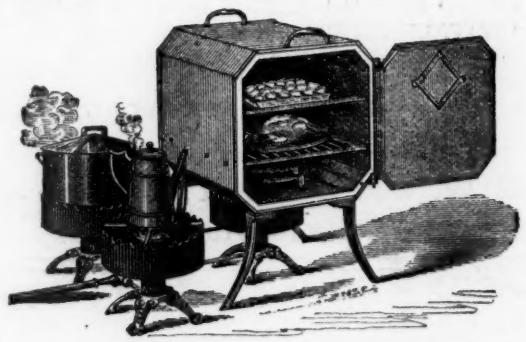

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